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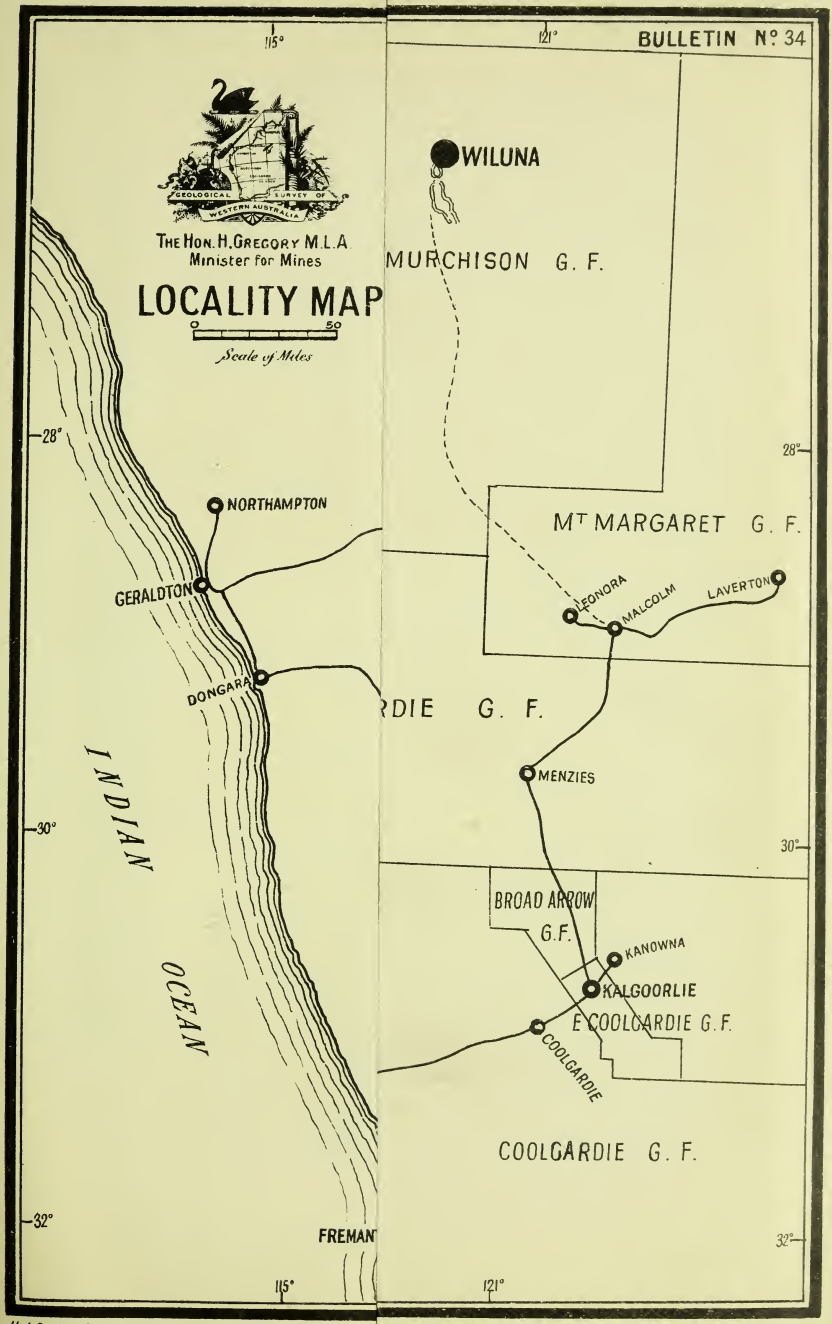
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BULLETIN Nº 34



THE HON. H. GREGORY M.L.A.
Minister for Mines

LOCALITY MAP

Scale of Miles

115° 117° 119° 121°

28° 30° 32°

MURCHISON G. F.

WILUNA

NANNINE

GUM Ck

E. MURCHISON G. F.

ERROLLS

BARRAMBIE

CUE

DAY DAWN

YALGOO G. F.

RABBIT PROOF FENCE

MT MARGARET G. F.

NORTHAMPTON

GERALDTON

DONGARA

LEONORA

MALCOLM

LAVERTON

N. COOLGARDIE G. F.

MENZIES

INDIAN OCEAN

BROAD ARROW G.F.

KANOWNA

KALGOORLIE

E. COOLGARDIE G.F.

COOLGARDIE

YALGOO G. F.

SOUTHERN CROSS

NORTHAM

YORK

PERTH

FREMANTLE

COOLGARDIE G. F.

H. J. Pether, Government Lithographer, Perth, W.A.

1908.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 34.

REPORT UPON THE AURIFEROUS DEPOSITS

OF

BARRAMBIE AND ERROLLS

(Cue District)

AND

GUM CREEK

(Nannine District)

IN THE

MURCHISON GOLDFIELD;

ALSO

WILUNA

(Lawlers District)

IN THE

EAST MURCHISON GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,

ASSISTANT GEOLOGIST.

Issued under the authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH TWO MAPS, THREE PLATES, AND SIX PHOTOGRAPHS.

PERTH:

BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.

1908.

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PREFATORY NOTE.

These reports upon certain centres in the Murchison and East Murchison Goldfields are the result of an examination made during the year by Mr. C. G. Gibson whilst engaged in mapping in upon broader lines the geological features of the latter field. As, however, his services were required as Geologist attached to the Transcontinental Railway Survey, it was found necessary to recall him before this work was completed.

Upon his journey across from Nannine he passed Barrambie and Errolls, the auriferous belt of which he describes as consisting of a chloritic schistose zone, enclosed in granite country of some 10 miles in length and three miles in width. The rocks of this area he considers belong to the acidic series, in which case they most probably are the result of the alteration and shearing of granodiorites similar to those carrying the auriferous lodes in the Cue district.

At Errolls the quartz lodes are apparently of the usual lenticular type met with in foliated rocks which, although often attaining considerable size in places, are not usually of any considerable longitudinal extent, whilst this same remark will in all probability apply to their vertical continuity.

At Barrambie, upon the other hand, the lodes although small apparently follow searing planes, and can be traced for a considerable length at the surface, and therefore give greater promise with regard to their permanency in depth.

In the Gum Creek district there appears to be a fairly extensive auriferous area, but, although a considerable quantity of stone has been crushed, which yielded over one ounce of fine gold to the ton, little is doing in this locality at the present time.

It is ten years since Mr. Blatchford, then Assistant Government Geologist, reported upon the Lake Way district, which is now known as Wiluna, and in consequence Mr. Gibson's report will be read with considerable interest, particularly as a new class of auriferous deposits is now being developed. He described the district as consisting entirely of greenstone schists, which class of rock extends over an area of some 1,240 square miles, for although they do not always appear at the surface they will be met with in sinking at a moderate depth. These greenstones, although very similar in appearance to those usually met with upon the other goldfields, are of a more highly siliceous character, thus more nearly approach quartz-diorite.

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The auriferous portion of this tract of country is apparently confined to a belt some three miles in length by one mile in width, having a north-westerly course, which direction is also followed by the quartz reefs which occur in lines having considerable length and degree of parallelism; they are not, however, continuous sheets, but a series of lenticular bodies the edges of which often over-lap one another, which character is common to these deposits in schistose country.

Besides the quartz reefs there are a series of so-called lodes which have more recently been discovered in this district to carry payable values in gold. These consist of zones of highly foliated or crushed rock, one series of which follows a parallel course to the reefs, whilst the other crosses them at about right angles. In this class of deposit the solutions have apparently found a free passage through the folii of the rocks upon the faces of which gold has been deposited, associated in places with large bunches of sulphide of Antimony said to be highly auriferous.

Acidic dykes are not of common occurrence, but two, composed of granite, are met with in the centre of the auriferous belt, whilst basic dykes, owing to their similarity to the altered greenstones, have not been observed at the surface; but Mr. Gibson mentions some belts of more highly foliated rocks which vary from a few feet to several chains in width, following a course a little to the west of north, which may possibly belong to this class.

The quartz bodies do not apparently carry gold values consistently throughout, but are sometimes richer upon one wall and sometimes upon the other, although in exceptional places the whole width of the vein pays to crush. The conclusion he arrives at is that although it is probable that these planes of quartz lenses will extend to a considerable depth, the values in gold will probably diminish below the zone of secondary enrichment; upon the other hand he speaks highly of the lodes of which he considers there is very considerable prospect of greater permanency in depth although probably not quite so rich as above the water level.

HARRY P. WOODWARD,

Acting Government Geologist.

Geological Survey Office,
Perth, 4th September, 1908.

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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

BARRAMBIE

MURCHISON G. F.

Scale of Chains.



GEOLOGY BY C. G. GIBSON ASSISTANT GEOLOGIST

DRAWN BY E. P. THOM

R. A. F. Maitland
Government Geologist.

RECENT DEPOSITS
IRONSTONE GRAVELS X
SCHISTS (Sandy) Sc
PEETS
SHAFTS
FOLIATION

GEOLOGICAL BOUNDARIES
LEASES (REGISTERED No OF 1650
POST No OF 1660
NAME OF TRIXIE
BOUNDARIES OF

H. J. Pether, Government Lithographer, Perth, W.A.

REPORT

UPON THE

Auriferous Deposits of Barrambie and Errolls (Cue District) and Gum Creek (Nannine District) in the Murchison Goldfield, also Wiluna (Lawlers District) in the East Murchison Goldfield.

BARRAMBIE.

This centre is situated near the 284-mile peg on the Rabbit Proof Fence, about 73 miles due east from Cue and 60 miles south-east from Nannine, the latter route being the one by which it is usually reached.

The district has already been reported upon by Mr. H. P. Woodward, the Assistant Government Geologist, and Mr. A. Montgomery, the State Mining Engineer. Mr. Woodward's report appears in the Annual Report of the Geological Survey for the year 1906 (page 15), and Mr. Montgomery's report in the Annual Report of the Department of Mines for the same year. Both these reports should be read in conjunction with the present one.

At the time of my visit, mining operations were not very brisk, the only property on which any systematic work was being done was the Barrambie Ranges G.M. Co.; in addition to this there were one or two small parties doing a little prospecting on the adjoining leases, but very little stone was being raised.

The principal leases are situated on the western fall of the Barrambie Ranges, which consist of a ridge of rugged hills trending a little west of north, and having a maximum height, towards their southern end, of a hundred and fifty to two hundred feet. Seen from the west, this range is very conspicuous as it rises abruptly out of a low-lying plain, but from the east it is hardly noticeable as it is backed by an elevated sandy tableland. The range is very rough since the rocks are very little weathered, and stand out boldly from its surface except upon its north-eastern side, where they are covered to a shallow depth with scattered areas of ironstone conglomerate (laterite).

The rocks comprising the range consist of somewhat chloritic schists resulting from the crushing and foliating of a highly horn-

blendic granite or grano-diorite. The predominating finer grained varieties of this schist very closely resemble the more ordinary chlorite schists, or foliated greenstones, of the Western Australian Goldfields, but a microscopic examination of it readily reveals its acidic (granitic) origin; whilst in the coarser varieties the original quartz grains can readily be seen on close examination of hand specimens. There is only a comparatively very small extent of these schists, and they are enclosed in the usual massive granite which is so prevalent on the Murchison and East Murchison Goldfields.

The belt extends from Errolls to possibly four or five miles south from Barrambie, thus having a total length of 12 or 15 miles, and an approximate maximum width of three miles. Northward beyond Errolls it disappears beneath extensive loamy plains (wanderie), these being continuous for many miles. At a point about eight miles north from Errolls, however, they are broken by a low ridge of hills similar to those at Barrambie, and are evidently a continuation of the same belt.

At the northern end of the Ranges, between Errolls and Barrambie, where the belt has its maximum width, there is a series of low hills and ridges with a few quartz reefs, but these are mostly small and apparently of no great value.

The junction between this belt and the granite country can be followed on the western side running from a point half-a-mile or so east of the Errolls leases in a direction south-south-easterly across the Rabbit Proof Fence, near the 280-mile peg; whilst on the eastern side it is mostly hidden by the deposits of loose sandy soil which cover the greater part of the country in this direction.

The general trend of the foliation of the schists is about north and south with a steep dip to the east. Well defined fault, or shear, lines occur along the strike of the schists, and it is along these lines that the quartz reefs occur. These, though at times of considerable length, are not usually of any great size, the one on which most of the work is, at present, being done is of an average thickness of less than eight inches. Generally more or less "formation" (crushed country) is found on either side of the quartz, varying in thickness from a few inches up to three or four feet, but this, as a rule, does not carry payable values which are confined to the quartz bodies. The quartz reefs will be more fully described under the individual mines. The country at the surface is fairly hard, and in the deeper workings is very tight and hard.

Water is not too plentiful, but is of fairly good quality, and usually suitable for domestic purposes. At present the supply for battery purposes is being drawn from a well on the flat about a mile to the south-west of the mines.

Timber for mining is somewhat scarce, but there is an ample supply of firewood.

At the time of my visit mining operations at Barrambie were not very brisk, the only systematic work being done was that at the

Barrambie Ranges Gold Mine, and that was not on a very large scale. On the two leases adjoining this property on the north a little prospecting work was being carried on, but up to that time no stone had been crushed from them. No other work worth mentioning was being done in this locality.

The Barrambie Ranges Gold Mine is equipped with a 10-head battery, and the manager informed me that he was endeavouring to make arrangements to utilise five head for crushing for the public. If this is done it should greatly encourage local prospecting for, under present conditions, stone has to be carted into Tuckanarra or Nannine, as there is no nearer public crushing plant in the district.

Barrambie Ranges G.M. Co., G.M.Ls. 1458/9, 1484, 1486, 1560.—This Company owns a group of leases situated on the western fall of the Barrambie Range, and underground work is being done on two of them, viz., G.M.Ls. 1458 and 1459, known respectively as the Golden Treasure and the Golden Hill, but mostly on the former, on which is situated the main shaft from which the Golden Hill is also being worked.

The work done on these leases up to the end of 1907 was as follows:—

On the Golden Treasure the reef has been opened up at the 100 feet (approximate) level for a distance of about 430 feet south from the north boundary. Two shafts have been sunk to this level on the underlay of the reef, one of these being the main shaft, and the other being known as the No. 2. The main shaft has been continued below the level for a further depth of 60 feet, and the No. 2 shaft for a depth of 45 feet, both on the underlay. The level runs for a distance of about 110 feet south of the main shaft, and over this length very little stoping has been done owing to the stone being poor at this end. North from the main shaft to the boundary practically all the stone above this level has been stoped out. Both the shafts on this lease are in a bad state, and unsuitable for working at a much greater depth than the present. Should future developments prove satisfactory a new main shaft will be required.

On the Golden Hill, the reef has been opened up for a length of a little over 200 feet at the 100 feet (approximate) level, these workings connecting with those on the Golden Treasure. A shaft (No. 3) has also been sunk on the underlay of the reef to this level, and continued as a winze for a further depth of about 70 feet. This shaft is at present useless except as a mullock pass and for ventilation purposes. A good deal of stone has been stoped out above this level, but there is a fair amount left, and at the present time most of the ore for the mill is being broken from this end of the mine. No stoping at all has been done below the 100 feet level on either of the leases.

The reef consists of a small quartz vein occurring in a narrow belt of much crushed chloritic schist; this schist, which is only a slightly more crushed portion of the country rock, varies in width from two to five feet, and is said to carry a little gold right along, but not sufficient to be payable. The quartz vein is somewhat broken, and occurs in a series of irregular lenses; it has a maximum thickness of eighteen inches, and an average of about six inches. The lenses, or shoots, appear to pitch to the north, but sufficient work has not been done at a depth to enable a definite opinion to be given on this point.

The general trend of the vein is slightly west of north and east of south, and for a vein of its size it is very persistent in strike, being traceable on the surface in a more or less continuous line for about half-a-mile. It has been opened up in the Company's leases for nearly 650 feet, and over the whole of this length, with the exception of only a few feet, there was continuous quartz, varying from a thread to fifteen or eighteen inches. This quartz vein carries fairly high values throughout its entire length, and near the surface some exceptionally rich pockets were found. The gold is said to have occurred principally in vughs evidently resulting from the oxidation of gold-bearing pyrites.

About four chains south of the main shaft the vein dies out completely, but there is a second reef running about north and south, and lying a chain or two west of the main line, which is commonly thought to be the faulted continuation of it. It appears to me, however, that the fissure, or shear, line along which the main vein has been formed continues on through this, and the adjoining leases being a continuation of the one in which the main Barrambie South quartz vein occurs. (*See* map.)

In the main shaft on the Golden Treasure lease the quartz has cut out a little below the 100 feet level, but the fissure appears to be still going on, and if this is followed down it is quite probable that another make of stone may come in; should this occur, however, the chances are that this stone will be considerably poorer than that in the upper or oxidised zone. A few feet below the point where the quartz cuts out there is a small make of stone going off into the hanging wall, but no work has been done to ascertain what this is; it may be, and very possibly is, only a short split of the main vein, whilst upon the other hand it may be the commencement of a good sized lens of stone; a short crosscut at the bottom of the shaft would soon prove this.

In both the winzes farther north the quartz vein is said to be going down just as strongly, and to carry equally good values.

So far no crosscutting has been done on the property; this seems rather a pity as parallel makes of stone are known to exist at the surface, and in country such as that in which the Barrambie vein occurs, these are always likely to be met with.

Table showing the Yield of the Barrambie Ranges Gold Mines.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1905	Golden Treasure, G.M.L. 1458	..	*6.54	..
1907	Barrambie Ranges G.M. Co., N.L., G.M.Ls. 1458/9, 1484, 1486, 1560	5,172.33	5,683.13	1.10
	Total	**5,172.33**	**5,689.67**	**1.10**

* Dollied.

Magnum Bonum, G.M.L. 1460 and *Trixie,* G.M.L. 1469.—These leases adjoin the Barrambie leases on the north. A little prospecting is being done on both of them on what is evidently the continuation of the Barrambie vein, which is here only a few inches in thickness but is said to carry fair gold. No work worth mentioning has been done on either of the leases and no stone has been crushed.

On the Magnum Bonum a second parallel make of stone has been opened up a few chains farther west which is from two to three feet in width at the surface and is very rubbly and broken; it is stated to be fairly low grade. Very little work has been done and no stone has been crushed, the only official return being 5.96 ozs. of gold obtained from dollying.

Other parallel bodies of stone occur on these leases but they are, as far as tested, of no value, and no work has been done on them.

Barrambie South Leases, G.M.Ls. 1467, 1488, etc.—Two lines of reef have been worked on these leases, one known as the West reef being on G.M.L. 1467, whilst the other, which is known as the East reef, is on G.M.L. 1488. At the time of my visit these leases were held under exemption from the labour conditions and the workings in consequence were inaccessible.

The work done on the West reef is said to be as follows:—A main shaft has been sunk 140 feet vertically and then on the underlay to a depth of 215 feet, but no driving has been carried on; it is said to have cut the reef at 140 feet, where two feet of broken quartz was encountered. About a chain north from this a second shaft is sunk to a depth of 50 feet and about 50 feet of driving done at the 35 feet level and 20 feet at the 50 feet level, but no stoping. Along the 35 feet level the quartz is said to have been very irregular, varying from five feet in width at the biggest part to almost nothing at each end. In the bottom level the quartz is said to have been from two to three feet in width.

A parcel of 5.09 tons of stone has been crushed from this reef, which yielded 29.70ozs. of fine gold, whilst 9.99ozs. were obtained by dollying.

Most of the work done on the property is on the east reef, and is said to be as follows:—The north, or main, shaft is sunk on the reef to a depth of 155 feet, and at the 100 feet level a drive has been put in about 20 feet north and 30 feet south; at the 35 feet level a drive is in 30 feet north and about 150 feet south, which connects with the south shaft (75 feet) at a point about 130 feet from the main shaft. No stoping has been done.

There is also a vertical shaft a chain or so farther east, but this has not been sunk to any great depth and no work is being done from it.

Along the 100 feet level the stone is said to have been from a couple of inches to one foot in thickness, and is respectively five and three inches in the north and south faces. In the north end of the 35 feet level the stone cuts out altogether, while in the south face it is about five inches; along the level it varies in width from a mere thread to a maximum of about thirty inches and the general value is said to be about 30dwts. but, although a lot of money has been spent on the property, no stone has so far been crushed.

In its occurrence the vein is similar to that in the Barrambie leases, being a small irregular quartz vein formed along a well defined shear line which runs parallel to, and dips with, the enclosing schists, *i.e.*, steeply to the east. The vein is traceable for a considerable distance on the surface and should be well worthy of a little more development if the values are as reputed.

Table showing the Yield from Leases at Barrambie, other than those already given, up to the end of 1907.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1907	General Kuropatkin, G.M.L. 1492	15.00	7.52	.50
1907	Queen, G.M.L. 1508 ..	55.00	52.27	.95
	Total	**70.00**	**59.79**	**.85**

ERROLLS.

This centre is situated about nine miles north-west from Barrambie and, if anything, mining operations here are even less brisk, for there is only one mine on which any systematic work is being done and one or two others which are in the prospecting stage.

The greater part of the country immediately around Errolls is flat and mostly covered with a varying thickness of loose sandy soil above which only a few occasional rock outcrops are visible.

A couple of miles west of the main workings is a line of low-weathered granite breakaways running about north and south, the

sandy flats extending right to their foot. This granite belt extends in an unbroken line easterly right across to Cue, the greater part of it being covered with a shallow depth of loose sandy soil and occasional patches of sand plain and spinifex.

East of the workings and distant about a mile and a half is a low ridge of hills formed by a belt of chloritic schists, which is the northern extension of the Barrambie Range belt. The junction of these schists with the main granite body is hidden beneath sandy flats but judging by the appearance of the surface soil it probably lies about a mile east of the main mine workings, these being entirely within the granite area.

The quartz reefs of the district are large, but with one exception, the Legacy, are of little length. Those at present being worked are entirely within the granite area and have a very marked lenticular habit, being strong solid bodies on the surface but cutting out rapidly in depth; it is however possible that they may make again if sunk on to a greater depth, but sufficient work has not been done on any of them to enable a very decided opinion to be expressed; practically nothing has been done below water level (about 50ft.). Personally, however, I am inclined to believe that they will not be found to live to any great depth.

Generally speaking, the average gold contents of these reefs are very low, but occasional fairly good patches are found which are irregular both in size and occurrence.

There is a fairly plentiful water supply in the district, which is met with at an average depth of from 40 to 50 feet; it is, however, not of much use for domestic purposes, being usually highly mineralised or brackish; but fortunately there is a plentiful supply of good water in the new Government well about a mile and a half north-east of the townsite.

Timber for mining purposes is not too abundant, but there is ample firewood for some time to come.

At the time of my visit mining operations were very quiet; on the Legacy (Wha Gold Mines, Ltd.) stone was being "rooted" out of a large open cut in sufficient quantity to keep the mill going, but no development work was being carried on. On one or two other leases a little prospecting was being done but only in a casual sort of way and nothing worth mentioning had been performed.

The Wha Gold Mines are equipped with a 10-head battery which occasionally crushes for the public; but so far very little stone has been treated from outside this Company's leases.

Legacy, G.M.L. 1531 (Wha Gold Mines, Ltd.).—On this property there is a large quartz reef running about north-north-west and dipping at a fairly flat angle to the west; this reef is traceable on the surface as a strong body of quartz for a length of over fifteen chains, having a thickness of fifteen to twenty feet in places. Very little work has been done on it, the deepet shaft, called the water shaft, being only down about seventy feet and little or no work has been done from this.

Practically all the stone crushed has been taken from a large open cut towards the south end of the lease, which has been carried down to a depth of from thirty to forty feet and a few short drives have been put in from it; at the surface the reef is stated to have been as much as twenty feet in width, but at a very shallow depth it runs out into a number of small veins, whilst at forty feet it has practically cut out altogether. These veins as a rule continue on the same underlie as the main body of the reef, but occasionally they branch off into the foot or hanging wall at a steeper or flatter angle than it.

On the footwall side of the main reef occasional flat reefs are found running out from it and on one of these a fair amount of work has been done; it has been followed a distance of about seventy feet from the main line and has an average thickness of three or four feet, whilst at one place it reaches as much as ten feet, but this appears to be petering out as it gets farther from the main body. It is probable that this reef has been formed in a flat induced fissure caused by the main one and that other similar reefs are likely to be found; but if so it is not probable that they will prove to be of great extent or permanency.

Right through the property the best values have been found on the footwall side of the reef and in the footwall makes of stone. The good stone usually carries a little pyrites, which is said to be high in gold, whilst at the surface vughs, containing a good deal of fine gold, occur, which result from the leaching out of the pyrites.

Several shafts have been sunk on the western side of the main reef, near the open cut, to a depth of about forty feet; these merely proved that the stone had pinched out at this depth and no effort was made to follow the line down to ascertain if it made again.

Some five chains or so north of the open cut, the reef on the surface has a width of about six feet, whilst in the water shaft at a depth of 50 feet it has pinched to about 18 inches; fifteen to twenty feet deeper in a short crosscut, the stone has opened out to a body ten feet in width which is said to be worth five or six dwts. of gold per ton, but no work has been done on it. This body of stone should be well worth opening up as this is the deepest point at which stone has been met with in the mine, and a little work here would very quickly show whether or not the reef is going to be permanent.

Farther north again the reef on the surface is very strong, being from 10 to 12 feet in width, but two shafts on the west side show the stone to have practically cut out again at about forty feet. Apparently no effort has been made to ascertain whether this reef makes again at a greater depth, the probability being that in this case it does, since a reef with a continuity on the surface of nearly 20 chains is not likely to die out altogether at a depth of 40 feet. Probably, however, if other bodies of quartz are met with they will be of lower grade than those on the surface. Taking the reef right through the

bulk of the stone is of too low grade to pay working expenses at the present time.

The water supply of the mine is fairly highly mineralised, and is very limited, but the quantity will probably increase on further sinking.

The total quantity of stone crushed up to the end of 1907 was 3,082 tons, which yielded 1,875.29ozs. of fine gold, or at the rate of .61oz. per ton.

Barrambie Perseverance, G.M.L. 1568.—This lease is situated about two miles south-south-easterly from the Legacy and upon it there is a large quartz blow having a general east and west strike and a dip to the northward. Towards the east end of the blow is a shallow open cut, from which about 70 tons of stone are said to have been crushed for a yield of about 6dwts. of gold per ton, but so far nothing defined in the way of a reef has been exposed, the open cut merely showing a broken mass of hard white quartz from 12 to 15 feet in width.

The "blow" is some five chains in total length and has a width up to 20 feet; a vertical shaft sunk to cut the reef at a depth of about 50 feet is said to have passed through only two to three feet of stone, showing that it does not carry its size in depth. The country in which the reef occurs is weathered granite.

Table showing the Yield from Leases at Errolls, other than those already given, up to the end of 1907.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1906/7	Inheritance, G.M.L. 1528	45.00	84.53	1.88
1906	Three Star, G.M.L. 1490	51.00	151.52	2.97
	Total	**96.00**	**236.05**	**2.45**

GUM CREEK.

This centre is situated on the Rabbit-proof Fence near the 330-mile peg, and about sixty-five miles east of Nannine.

There is here a large belt of auriferous country, having a total width of about fifteen miles, and a known length of over twenty miles. Its northern extremity is some four or five miles north of the 330-mile peg, and it then widens out rapidly both ways attaining its maximum width approximately at a point where it is crossed by the Lake Way road near the 320-mile peg. South-westerly from this, it extends for about ten miles, but its south-eastern boundary has not been followed, but it probably stretches in this direction for at least fifteen miles.

A portion of this belt of country is flat, and covered with extensive areas of recent detrital deposits, but the bulk of it is hilly over which the rocks outcrop. These rocks consist of massive and schistose greenstones similar to those found at Montague and Wiluna. They are slightly more acidic than the type of greenstones usually found on the Western Australian Goldfields, the original rock approaching a quartz diorite in composition.

Within this greenstone area quartz reefs are numerous, more especially towards the northern end where most of the leases were situated. These reefs are often of considerable size, the quartz in them being, for the most part, hard, white and glassy; many of them have been proved to be auriferous, but the values so far have not been satisfactory.

Several leases have been taken up and worked during the last two years at the north end of the district, but developments were not encouraging, and at the time of my visit they were all abandoned. One or two dryblowers were working on the old alluvial patches, but this centre was to all intents and purposes abandoned.

Some twelve or fourteen miles south-west from the old leases a small party was said to be working a quartz reef, and to be raising some fair stone; this lease, however, was not inspected.

At the time when the leases at the north end were working there was a small battery on the spot, at which prospectors could get their stone crushed; this, however, has been removed, and any stone now raised has to be carted into Nannine for crushing.

The water supply is fresh and abundant.

The district was reported upon in 1906 by the State Mining Engineer (Mr. A. Montgomery), who visited the leases when most of them were being worked, and could be inspected. His report appears in the Annual Report of the Department of Mines for the year 1906, page 103.

Table showing the Yield from Leases at Gum Creek.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1905/7	Cardigan, G.M.L. 501N ..	334.83	503.47	1.50
1904/6	Cardigan North, G.M.L. 536N	123.50	58.17	.47
1906/7	Gladsome, G.M.L. 590N ..	591.00	268.44	.45
1907	Gladsome, G.M.L. 757N	..	*172.66	..
1906/7	Hilda No. 1, G.M.L. 672N	51.25	62.38	1.21
1906	Hilda No. 2, G.M.L. 671N	17.00	†87.00	5.11
1906	Pick-me-up, G.M.L. 587N	77.00	26.28	.34
1905/7	Pretty Polly, G.M.L. 576N	68.00	‡189.92	2.79
1903/7	Sundry Claims	148.00	84.32	.57
	Total	**1,410.58**	**1,452.64**	**1.03**

* By Cyanide. † Includes 73ozs. dollied. ‡ Includes 40.39ozs. alluvial and dollied

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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

PLAN SHEWING THE AURIFEROUS REEFS & LODES OF

WILUNA

E. MURCHISON G.F.

0 20 40 60 80

Scale of chains

BULLETIN Nº 34.

The Hon. H. Gregory M.L.A. Minister for Mines

WILUNA TOWNSHIP

DARLINGTON 875 137 MONARCH OF THE EAST 149 DERWENT 933 442 LADY OF THE LAKE 378 DERWENT S. 340 LADY MARGARET 874 HIGHLAND MARY 189 DARA 990 332 WILD DUCK BLACK SWAN N. 980 170 WHITE SWAN BLACK SWAN 677 TRY AGAIN 4945 HOSPITAL Res. 6724 CEMETERY Res. 4946 RECREATION Res. 9909 STATE BATTERY 8468 HOSPITAL Res. 326 WEELONA 8384 RUBBISH Res. 4948 CEMETERY 7662 EXPLOSIVES Res. 1000 BOXING DAY 997 FULL HAND 956 LONE HAND 902 N. MOONLIGHT 1006 STORM KING 870 MOONLIGHT 974 ADELAIDE EX. 977 MOONLIGHT E. 940 ADELAIDE 983 959 ADELAIDE JUNTN 973 ADELAIDE S. MOTHER OF GWALIA 993 SEMAPHORE 987 CONNECTING LINK 951 GWALIA EXTN Nº2 GWALIA EXTN Nº1 1001 WARATAH 1016 GOLDEN BRACLET 969 GRAND JUNCTION 967 RED PAGE 959 BULLETIN N 964 R. M. G. 946 HOP 975 MOONLIGHT E 972 BULLETIN W 951 INDICATION 1008 BULLETIN PROPRIETARY 917 SQUIB 1002 DRY DOG ALL NATIONS 963 DAWN OF HOPE 143 140 BROTHERS GOLDEN AGE 928 1014 316 CHANGE OF LUCK ESSEX 644 EMERALD ISLE REPUBLIC 252 LADY ROPER 7835 RACE-COURSE 930 943 551 937 545 LAKE VIOLET CONSLS N.E. LAKE VIOLET CONSLS N.W. 931 546 542 550 LAKE VIOLET CONSLS W. LAKE VIOLET CONSOLS LAKE VIOLET CONSLS E. 309 ROSE 314 LAWLESS 548 952 549 LAKE VIOLET CONSLS S.W. LAKE VIOLET CONSLS S. 932 547 LAKE VIOLET CONSLS S.E. 944 938 569 LAKE VIOLET CONSLS S.W.Ex. LAKE VIOLET CONSLS S.E.Ex. 966 961 WILUNA QUEEN W WILUNA QUEEN 162 LAKE WAY 163 LAKE WAY S. 1003 LAKE VIOLET

Alibb Maitland
Government Geologist

By C. G. Gibson Assistant Geologist.
Drawn by R. W. Irwin 9. 9. 08.

EXPLANATION.

GRANITE DYKES ..... Gn

REEFS .....

LODES .....

LINES OF FOLIATION ..... MINERS HOMESTEAD LEASE ..... M.H.L. TAILINGS AREA T.A. MACHINERY AREA M.A. GARDEN AREA G.A. WATER RIGHT W.R.

LEASES { REGISTERED Nº OF ..... 931 ; POST Nº OF ..... 546 ; NAME OF ..... LAKE VIOLET CONSLS E. ; BOUNDARIES OF .....

EXTINCT LEASES SHEWN BY DOTTED LINES

H. J. Pether, Government Lithographer, Perth, W.A.

WILUNA.

The town of Wiluna is situated about a hundred and twenty miles slightly north of east of Nannine, which is the nearest railway station, and to which it is connected by a weekly coach service.

The only detailed report which has been previously made on the district is that by the then Assistant Government Geologist (Mr. Blatchford), who examined and reported on the field in 1898. His report, together with an explanatory geological map, appears in the Annual Report of the Geological Survey for the year 1898, in which he states that he "was at once struck with the similarity of the enclosing country rocks, which in all cases where they outcropped proved to be either granite or mica and quartz schists, the latter arising, no doubt, from the metamorphism of the former."

Personal observations have proved these so-called mica schists to be merely a silicified and weathered belt of greenstone schists, the rock in the main being the same right throughout the district.

As Mr. Blatchford during his visit examined a number of mine workings which at the time of my visit were inaccessible, I have in this report made partial use of his descriptions when dealing with some of the mines in question.

There is a large extent of auriferous country, the belt being first entered on, when travelling in an easterly direction, at Mt. Merewether, about twenty-five miles from Wiluna, and extending for at least six miles beyond that place, but how much farther is not known. It extends to the north and south from a point some five or six miles south of Mt. Laurence Wells to about twenty miles north of Wiluna, being a total length of at least forty miles.

The greater part of this area is covered with the ubiquitous recent deposits, often to a considerable depth, but at Mt. Merewether, and from thence north-easterly there is a considerable extent of hilly country where the rocks outcrop, and which should be well worthy of the prospector's attention; near Mt. Laurence Wells, also, there is a nice looking patch of country which, however, appears to have been fairly well prospected, but with what results I was unable to learn.

In the neighbourhood of Wiluna townsite, covering the area over which the leases extend, and also for some miles northward the country is somewhat hilly, series of low rounded greenstone ridges rising to a height of about one hundred feet; south and west, however, are extensive flats which have a general fall southerly into Lake Way.

The rocks comprising this auriferous belt are similar to those at Gum Creek and Montague, and practically the same as found on all the Western Australian Goldfields, the only difference being that those of the Wiluna belt are apparently slightly more acidic than those of the fields farther south. They are as a rule massive and fairly fined grained, and consist of hornblende rocks often approaching quartz diorite in composition.

In the Wiluna district well defined narrow belts of schists are frequently found traversing the main greenstone body; these usually run on a bearing slightly west of north, and vary in width from a few feet to several chains; they are merely crushed zones of country rock and apparently mark old main fault, or shear, lines, and it is generally along them that the main lines of quartz reefs and lodes occur.

These schists are usually much weathered at the surface, and frequently considerably silicified, in which cases they closely resemble in appearance a crushed granite or quartz porphyry.

The ore deposits of Wiluna fall naturally into two main classes, viz.:—

(a.) The Quartz Reefs,
(b.) The Lodes.

Of these the latter are at the present time of by far the greater economic importance, as it is upon them that the permanency of the district depends.

The Quartz Reefs.—By reference to the accompanying map of Wiluna, it will be seen that the quartz reefs exhibit a very marked degree of parallelism, and also that they fall into two main groups, an eastern and a western.

The eastern group includes the Caledonia, Black Swan, Try Again, and Lake Way lines of reef, with their southerly extension; whilst the western group includes the Monarch, Lady of the Lake, Weeloona, and Golden Age lines. At the south end of the field is a third main parallel series, including the Lawler's reef, and what is known as the "Buck" reef of the Gwalia Consolidated; this series probably is the continuation of a well defined line occurring at the north end of the field in the Lady Margaretta and Derwent leases.

Within these groups the individual reefs are often of great size, frequently reaching twenty feet in thickness, and rising as conspicuous hills of quartz to as much as 40 or 50 feet above the surrounding country; at times they outcrop as continuous bodies of quartz for a distance of fully a mile, and at others they consist of a series of lenticular bodies of varying length, these sometimes overlap and at others are separated by a distance of over a chain. In the case of this latter class of reef the quartz bodies as a rule do not occur in an exact straight line, but lie either to the right or to the left, the displacement usually varying from half-a-chain to one chain. Even when the reefs outcrop continuously they exhibit a marked lenticular habit.

In many cases the quartz lenses owe their displacement to small cross faults, these being often marked by small veins of quartz, but this does not appear to be always the case; several of these small cross faults are especially well marked in the case of the Lake Way reef.

All the quartz reefs occur within well defined narrow belts of schist which mark main shearing, or fault, lines; these schists are

best defined and most noticeable along the line of the lenticular quartz bodies and are particularly well developed along the Weeloona line.

The best idea of the general extent, etc., of these reefs can be got by a reference to the map herewith.

In this District attention was first paid to the quartz reefs which have been worked on and off for twelve years, but little or nothing has been done below a vertical depth of 250 feet, and at the present time most of the work is being carried on by small parties of men who are "picking" crushings from near the surface.

Generally speaking, developments have not proved very satisfactory, for although the reefs are large the gold occurs only in small and irregular shoots, whilst the bulk of the stone is too poor to crush. These shoots, which apparently have a tendency to cut out at a shallow depth, occur usually near the walls of the reefs, sometimes on the hanging and sometimes on the footwall, whilst at times the whole width of the reef carries payable values

As far as development in depth has gone the reefs, though exhibiting their lenticular habit vertically as well as horizontally, show no signs of cutting out and personally I think they should live to a very considerable depth; the permanency of the quartz, however, is of very little economic importance if the gold should cut out, and, unfortunately, so far such appears to be the tendency.

A fuller description of the individual quartz reefs will be found under the heading of the leases on which they have been worked.

The Lodes.—These have been worked principally towards the southern end of the district where, in addition to occurring in parallel series with the main lines of quartz reefs, they are found running practically at right angles to them, the two series probably having an intimate connection.

The lodes consist of zones of crushed rock marking old fault, or shear, lines along which the country rock has been crushed and shattered over a considerable width, and cleavage planes and cracks have been formed, along which gold-bearing solutions have had access. Within the weathered zone near the surface the extent of this shattering with its resultant cracks has been very considerable and, the rocks being soft, the gold-bearing solutions have to a certain extent been able to percolate on either side of the cracks and fissures, thus impregnating the country rock over considerable areas; this accounts for the apparent great size of the ore bodies and their irregularity near the surface, the gold values being naturally higher where the cracks and cleavages are most numerous and low in those parts which have to a greater extent resisted crushing and fracturing. At a depth, when more settled and unweathered country is met with, the lateral extent of these ore bodies will probably be found to become considerably less and the values to follow well defined channels instead of, as in the present workings, being disseminated through considerable widths of weathered country.

These channels are of undoubtedly deep-seated origin and there need be no fear whatever as to the probable permanency of the ore bodies; whether or not the gold values will live down with them is a matter which can only be definitely settled by actual deep work. Allowing for a certain decrease owing to the enrichment within the zone of oxidation there is no reason whatever why they should not do so.

The series of shear (fault ?) lines along which these ore bodies occur appears to be part of that along which the large quartz reefs are found, since, in one or two instances, the quartz reefs can be seen on the surface to die out and give place to the typical lode formations.

In these lodes are frequently found small deposits of massive stibnite (sulphide of antimony) which are said to be high in gold contents, but so far no effort has been made to treat them. Their occurrence seems to be restricted entirely to the lodes for, as far as I was able to learn, stibnite has not been found in any of the quartz reefs. It is not as a rule found disseminated in small quantities throughout the ore but usually occurs in small lenticular bodies containing up to perhaps a ton or more, and can thus be easily separated from the ore and put aside; consequently it does not interfere to any great extent in the metallurgical treatment of the ore. Samples of stibnite are said to have assayed as high as 17ozs. of gold per ton, but this appears to be exceptional.

It is only comparatively recently that these lodes have been worked in the district and nothing has been done on them to any depth; on the Gwalia Consolidated, which is the oldest line worked, the workings are all at the 100 feet level and on none of the other lines has anything been done at a greater depth.

Systematic prospecting should result in the discovery of many other of these "lodes" as the schist belts (shear lines) along which they occur are plentiful and well defined, and it is therefore only natural to assume that other payable ore bodies will be met with along them.

Alluvial Gold.—A few small patches have been worked at the south end of the district for alluvial, or more correctly speaking, detrital, gold where it appears to have been obtained within a few inches of the surface, and several good sized pieces are said to have been found. The patches have long since been worked out and nothing is being done in this line now.

Water Supply.—The district as a whole is well supplied with water; at the north end of the field this is fresh, but at the south end, towards Lake Way, it is salt and the level is only about thirty feet but the supply is inexhaustible. Towards the north end the level varies from 50 to 80 feet and the supply is plentiful.

It is only in the vicinity of the Lake that salt water is met with, the supply throughout the field, as a whole, being fresh.

Timber.—Timber is somewhat scarce in this district, and the supply is practically all mulga, the best being rapidly cut out: there



West end of Lake Violet—Gwalia Consolidated Mine in distance.

is, however, a fair amount of firewood still available. A little gum timber is procured along the creek beds, but the supply is very limited.

Table showing the Yield from the Wiluna Mining Centre up to the end of 1907.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	40.00	*296.70	7.41
1898	2,473.55	†3,066.68	1.24
1899	6,101.35	‡4,748.29	.78
1900	15,541.00	10,567.70	.68
1901	6,715.00	7,255.73	1.08
1902	30,648.00	13,696.86	.45
1903	23,816.00	9,274.17	.39
1904	13,097.50	9,526.37	.73
1905	20,408.50	§ 11,018.50	.54
1906	21,203.82	8,969.90	.42
1907	32,889.00	13,097.44	.40
Total ..	**172,933.72**	‖**91,518.34**	**·53**

* Includes 106·39ozs. dollied. † Includes 428.47 ozs. dollied. ‡ Includes 2.20 ozs. dollied. § Includes .21oz. dollied. ‖ Includes 537.27ozs. dollied.

THE MINES.

Monarch of the East, G.M.L. 137.—This property was abandoned at the time of my visit and the workings could not be inspected. The main line of reef worked is strong and well defined, running through almost the full length of the lease on a bearing practically due north and south and dipping steeply to the west. In addition to this, there is at the north end of the lease a second parallel and much smaller reef a chain or so farther west on which a little work has been done.

Towards the south end of the lease, the main reef cuts out, but another make of stone comes in a chain or so east and runs for a short distance when it also dies out and a third make comes in another chain farther east; this third body of stone continues as a strong reef right through the adjoining lease (Lady of the Lake).

All the quartz bodies are probably formed along one main line of shearing, this being apparently the same as that on which the Weeloona reefs are situated.

The main Monarch reef is said to have been very irregular in size, varying from a few inches up to eight or nine feet; the shoots of gold are also said to have been irregular and small.

Lady of the Lake, G.M.L. 442.—On this lease, which adjoins the Monarch on the south, a good deal of work has been done down to

water level; these workings however were abandoned and were inaccessible. At the time of my visit a little prospecting work was going on along the surface in the hope of picking up a new shoot of gold. The reef is large and well defined, being up to ten and twelve feet in width; the quartz is hard and white and often a good deal laminated.

The gold occurs in small irregular shoots, being usually found on one or other of the walls; these shoots are said to have been very good at the surface but to have cut out at a fairly shallow depth.

Table showing the Yield of the Monarch of the East Leases.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total.		Average Rate per Ton.
					Ore Crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898	Monarch of the East G.M. Co., N.L., G.M.Ls. 137, 442	550.00	287.69	.52			
1899	Do.	1,965.00	1,550.74	.79			
1900	Do.	2,333.00	1,639.42	.70			
1901	Do.	2,762.00	1,799.83	.65			
1902	Do.	2,268.00	1,928.40	.85			
1903	Do.	655.00	691.63	1.06			
1904	Do.	632.00	272.47	.43			
1905	Do.	1,056.00	659.20	.62			
1906	Do.	30.00	58.89	1.96			
					12,251.00	8,888.27	.73
1907	Monarch of the East, G.M.L. 137	..	..	..	222.00	131.71	.59
1907	Lady of the Lake, G.M.L. 933 (late 442)	..	..	..	91.00	108.53	1.19
	Total	..	..	..	12,564.00	9,128.51	.72



A Portion of Lake Violet.

Highland Mary, G.M.L. 674.—This is another abandoned lease, but only a little work has been done on it. There is a very large body of quartz here, the main reef extending through the full length of the lease, and being up to twenty feet in thickness at the surface.

Towards the south end there is a second parallel reef lying a couple of chains to the west. Both these reefs strike slightly west of north, and underlie steeply to the west. They have the usual lenticular character, but not to such a marked extent as some of the reefs. Very little stone has been crushed, and the results were not satisfactory.

This reef is on the same line as the preceding one, and also as the Weeloona.

Up to the end of 1907, the total stone crushed from this lease was 44 tons for 11.53 ounces.

Weeloona, G.M.L. 326.—A lot of work has been done on this lease down to water level, but it is now abandoned, and the workings are inaccessible.

The reef consists of a series of lenticular bodies of quartz varying in length from two to eight chains, and usually separated by a distance of twenty to sixty feet, all occurring within a well defined belt of schist a couple of chains in width. A little south of this lease these quartz bodies die out, but northward they continue in a well-defined line for a distance of over a mile, having a general trend a little north of north-west; in this direction some of them are of considerable length, one on Machine Area 23 reaching over twenty chains in length, and being up to twelve or fifteen feet in thickness at the surface; little or no work has been done on any of them north of the Weeloona.

On the Weeloona the average width of these quartz bodies on the surface is three to four feet, and they have a uniform underlie to the west of 60 to 70 degrees; the footwall as far as could be seen is very clean and regular, but the hanging-wall is not so good; the quartz being clean and white and very hard.

In speaking of this property in 1898, Mr. Blatchford says:—" . . . . . . along the 70 feet level the reef varies from 18 inches to three feet in thickness. A large quantity of the quartz, which is

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Note.—The figures given throughout this report have been supplied by the Statist's Branch of the Mines Department and are complete up to the end of 1907.

Owing to the manner in which the returns have been made in past years it has been found impossible to obtain the exact returns from individual leases as these have frequently been included with those from other leases when they have been the property of the one Company, *e.g.*, the returns from the Derwent are given partly under the heading of the lease itself and partly included in those of two separate companies owning a large number of leases, it being in these latter cases impossible to separate the returns from the different leases; and this occurs in many other cases.

of the white opaque variety, is charged with a dark hard mineral, which, on analysis, proved to be sulph-antimonide of lead and copper, the copper being largely in excess. Carbonate of copper stains are also of common experience."

Table showing the Yield of the Weeloona Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897	Weeloona, G.M.Ls. 181, 326	..	*15.59	..
1898	Do	128.00	235.06	1.84
1899	Do	133.00	206.74	1.55
1904	Do.	364.00	122.22	.34
1905	Do.	235.00	185.17	.79
	Total	**860.00**	**764.78**	**.89**

* Dollied.

Darlington, G.M.L. 875.—This lease is on the north end of the western group or line of reefs, which includes those of the Derwent and Lady Margaretta.

On the north end of the lease is a large quartz reef running north and south, on which a little work has been done; towards the middle of the lease this reef has been faulted, and thrown about five chains to the east by a cross reef striking north-west and south-east, and dipping to the north-east.

The main reef is up to three and four feet in width at the surface, and is of the usual hard white quartz.

This lease has been abandoned for some time, and the workings were inaccessible. The total stone crushed up to the end of 1907 was 40 tons for 43.14 ounces.

Derwent, G.M.L. 149.—Running through this lease and northwards into the Monarch of the East is a large quartz reef striking almost due north and south, and underlying at a steep angle to the west. This reef outcrops continuously over a length of about fifteen chains, and on the surface has an average thickness of four to eight feet. A good deal of work has been done on it down to a depth of about 120 feet, but the workings have been abandoned for some time, and were inaccessible.

In describing these workings, Mr. Blatchford in 1898 states that " . . . . . Along the 50 feet level the reef has an average thickness of eight feet; . . . . . the character of the quartz is white and opaque, being much honey-combed in places; it contains free gold, iron pyrites, and probably some small quantities of copper sulphides."

At the time of my visit a little work was being done near the surface on a small vein of good stone running along the hanging

wall side of the main reef; this vein was from six to eighteen inches in thickness, and was said to be fairly good, but the shoot was of short length, and was nearly worked out.

From what I was able to gather it appears that the original workings were on a similar small vein, and that the shoots of good stone were small, being of no value.

The returns from this lease subsequent to 1899 were included partly in those of the Lake Way Goldfield, 1899, Ltd., and partly in the Gwalia Consolidated, Ltd.

Table showing the Yield of the Derwent Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.
		tons.	ozs.	ozs.
1898	Derwent, G.M.L. 149 ..	98.30	223.14	2.27
1899	Do.	66.00	127.83	1.94
	Total	**164.30**	**350.97**	**2.13**

Derwent South and *Lady Margaretta,* G.M.Ls. 378, 375.—On these leases the main line of reefs runs a good deal more west of north than in the Derwent, and on the former very little work has been done, but on the Lady Margaretta (late Gem G.M.L. 469) a good deal appears to have been carried out above water level. Both these leases are at present abandoned, and the workings were inaccessible.

On the Lady Margaretta the reef is of the usual lenticular form, occurring in a well-defined wide belt of schist, the quartz bodies, or lenses, having on the surface a width of from two to four feet.

Table showing the Yield of the Gem Lease (now Lady Margaretta).

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898	Gem, G.M.L. 340 ..	226.55	214.92	.95
1899	Do.	100.00	90.83	.91
1901	Gem, G.M.L. 469 ..	151.00	153.30	1.02
1902	Do.	67.00	52.45	.78
	Total	**544.55**	**511.50**	**·94**

Caledonia, G.M.L. 161.—This lease is situated on the north end of the eastern, or Black Swan group, which includes the reefs of the Dark Horse, Black Swan, Try Again, and Lake Way leases.

The reefs comprising this group, and running through the above and other leases for a total length of over two miles, are not actu-

ally continuous, but consist of a series of lenticular bodies of quartz occurring along the one well-defined shear or fault line; the length of these bodies varies considerably as also does the distance between them; this can best be seen by a reference to the map herewith.

On the Caledonia are two reefs, an eastern, on which all the work has been done, and a western; the former having also been worked on the Dark Horse, the adjoining lease on the south.

The western reef is by far the largest, and outcrops as a continuous body for a distance of over half-a-mile; it is of hard white quartz, and up to twenty or thirty feet in width in places; little or no work has been done on it, and its gold contents appear to be *nil*. The eastern reef is much smaller, averaging in width from two to six feet; the quartz appears to be continuous right through this lease and into the next, having a total length of over twenty chains; the strike of the reef is about 30 degrees west of north, dipping steeply to the west. A good deal of work has been done on this reef, but the old workings have been abandoned, and they were inaccessible.

At the time of my visit a little work was being done near the surface at the north end of the lease, the shoot being said to be small and to be nearly worked out. As far as I could learn all the shoots of gold were small and irregular and did not live down, the bulk of the stone being too poor to pay for working.

The main shaft on this property is down to a vertical depth of 250 feet (?), and at the present time it is being used as a fresh water shaft by the Gwalia Consolidated, Ltd., the supply being fresh and abundant.

In 1898 a return is given of 294 tons of stone crushed, which yielded 296.10 ounces of fine gold, but since that date the returns have been included with the Lake Way Goldfield, 1899, Ltd.

Dark Horse, G.M.L. 169.—Upon this lease a good deal of work has been done on the same body of stone as on the preceding lease, and also on several other reefs farther south along the same line (see map). All the workings, however, are now abandoned, and were inaccessible.

The quartz is of the usual hard white and opaque variety, and on the surface varies from two to six feet in thickness. The gold is said to have occurred in small irregular shoots, and developments were not satisfactory, whilst these shoots appear to have been principally on the footwall side of the reef, as most of the work seems to have been done on this side.

At the present time a little prospecting work is being carried on on the surface near the south end of the lease.

In his report on this property in 1898, Mr. Blatchford states:—"..... On this reef there are two shafts with a vertical depth of 45 and 70 feet respectively. Driving has been done to some extent both north and south along the reef, which varies from two to eight feet in thickness. A water shaft to the west, 65 feet deep, contains good water for drinking and domestic purposes."



Quartz Blow, 14 miles South of Wiluna.

Table showing the Yield of the Lake Way Goldfield, 1899, Ltd., Leases.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total.		Rate per Ton.
					Ore Crushed.	Gold therefrom.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1897	Dark Horse, G.M.L. 169 ..	10.00	97.88	9.79			
1898	Do.	184.15	381.56	2.07			
1899	Do.	80.00	91.80	1.15			
		..	..	..	274.15	571.24	2.08
1898	Caledonia, G.M.L. 161	..	..	..	294.00	296.10	1.01
1900	Lake Way Goldfield, 1899, Ltd., G.M.Ls. 149, 161, 169, 170, 184, 312, 332/3, 358, 378/9, 472/3, 513/4	2,540.00	2,749.64	1.08			
1901	Do.	..	*360.46	..			
1902	Do.	3,422.00	1,475.61	.43			
1903	Do.	..	..	..			
1904	Do.	213.00	537.26	2.52			
1905	Do.	1,227.00	1,869.87	1.52			
1906	Do.	841.00	967.56	1.15			
		..	..	..	8,243.00	7,960.40	.96
	Total	..	..	..	8,811.15	8,827.74	1.00

* From Cyanide.

Black Swan Leases, G.M.Ls. 170, 332.—Between these leases and the Dark Horse there is a considerable break in the line of quartz bodies occurring over a length of eight to ten chains. On the black Swan lease (G.M.L. 170) the makes of quartz are not so continuous as usual, being with the exception of that at the north end, only four or five chains in length; they are large, however, often reaching on the surface a thickness of over twelve feet; the north body has an apparent continuous length of about ten chains. A good deal of work has been done on this lease, but the workings are now abandoned, and inaccessible. On the adjoining lease to

the north (G.M.L. 332) a little work is being done near the surface. The gold in this reef has been found principally on the hanging-wall, but the shoots were small and irregular, the bulk of the stone being of no value; in size the reef varies from four to twelve feet, and is of hard white opaque quartz.

Near the south end of the lease a little surface prospecting is being done on another large body of quartz in the hope of picking up a new shoot of gold.

The returns from these leases between the years 1898 and 1906 are included in those of the Gwalia Consolidated, Ltd., and the Lake Way Goldfield, 1899, Ltd.

Table showing the Yield of the Black Swan Leases.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total. Ore Crushed.	Total. Gold therefrom.	Rate per Ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898	Black Swan, G.M.L. 170 ..	..	..	..	77.00	207.07	2.69
1898	Black Swan North, G.M.L. 332	..	..	..	14.50	22.59	1.56
1906	Gwalia Cons ldated, Ltd., G.M.L. 170	494.00	425.10	.86			
1907	Do.	435.00	167.31	.38	929.00	592.41	.64
	Total	..	..	..	**1,020.50**	**822.07**	**.80**

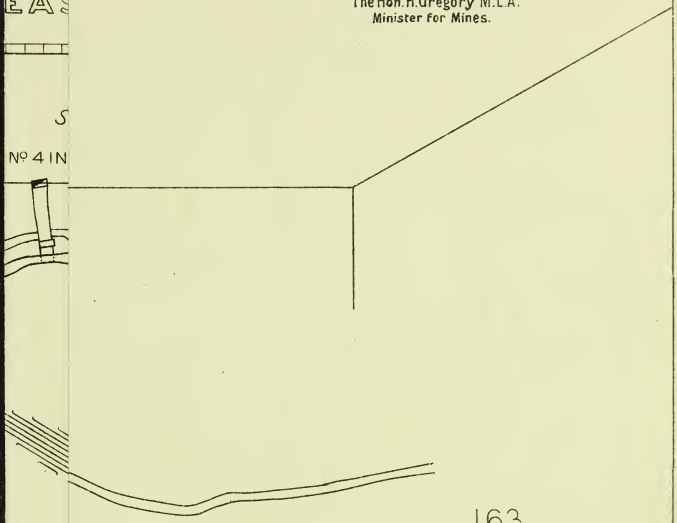


North Pool (12 miles North of Wiluna), looking South.

BULLETIN Nº 34 PLATE I



The Hon. H. Gregory M.L.A.
Minister for Mines.



163

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PLAN & SECTION OF

THE LAKE WAY G. M.

WILUNA

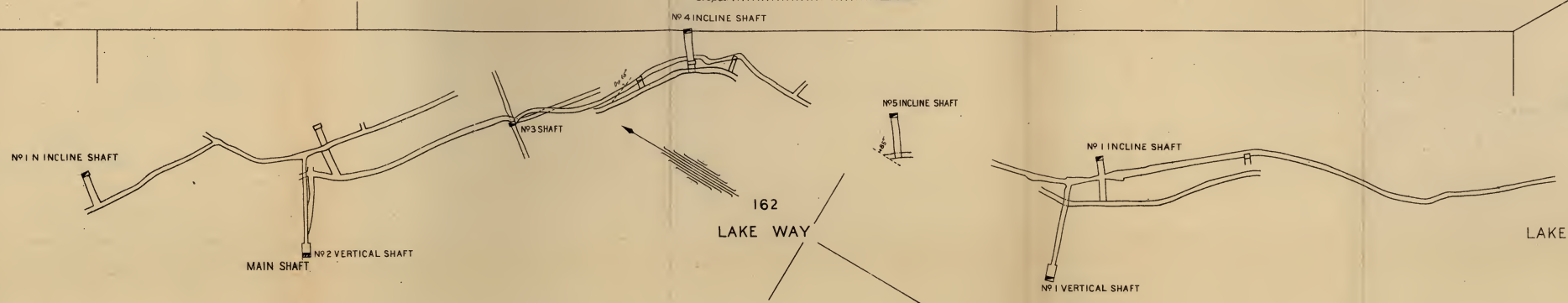
EAST MURCHISON G. F.

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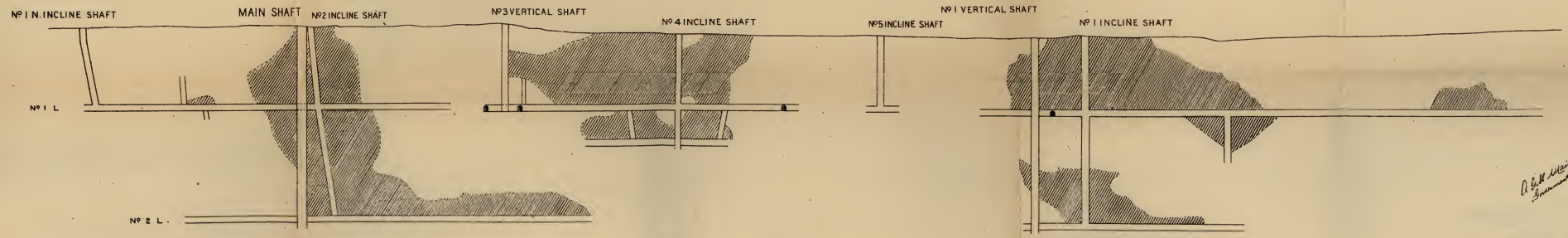
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Stoped.....

The Hon. H. Gregory M. L. A.
Minister For Mines.



LONGITUDINAL SECTION



TAKEN FROM MINE PLANS

A. G. H. Hutchison
Government Geologist

C. B. Kidson, del.
14. 8. 08.

H. J. Pecher, Government Lithographer, Perth, W. A.

Try Again and *Try Again Extended,* G.M.Ls. 677, 945.—These leases are both farther south on the same line as the Black Swan. A good deal has been done on the Try Again, but most of the old workings have been abandoned, and the work at present being carried on is all at, or near, the surface; only a little prospecting is being done on the Try Again Extended.

The reef on these leases consists of the usual series of lenticular quartz bodies, which vary greatly in length and size, some of them being up to 12 feet in thickness.

The shoots of gold appear to have occurred both on the hanging and footwall sides of the main quartz bodies, but, as usual, they are said to have been small and irregular.

Table showing the Yield of the Try Again Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904	Try Again, G.M.L. 677 ..	310.00	145.70	.47
1905	Do.	244.00	139.76	.57
1906	Do.	275.00	105.05	.38
1907	Do.	245.00	400.52	1.63
	Total	**1,074.00**	**791.03**	**·74**

Lake Way Leases, G.M.Ls. 162, 163.—A reference to the underground plans herewith (Plate I.), will show the amount of work that has been done on this lease. The workings have been abandoned for some time, and were inaccessible, so that an inspection of them could not be made.

The reef is of the usual type, consisting of a series of lenticular quartz bodies of varying length and size; these have in several cases been faulted across, the lines of the faults being clearly seen in the surface workings; these faults are always parallel, and strike slightly east of north, dipping to the west; the displacement of the main line is usually about a chain, and is always to the right; in one or two cases small quartz veins have been formed along the lines of fault, which are very local, and do not extend across country for any distance.

On the surface the size of the main bodies of quartz varies from two to eight feet; throughout the workings the reef is said to have been from two to six feet, averaging three or four feet, and on the whole to have been a good deal more regular than is usually the case with the quartz reefs of the district.

Along the bottom level the quartz is said to be going down just as strong as ever, and with every sign of permanency; the values, however, were not very good.

The gold as usual is said to have occurred in irregular she the bulk of the stone being of too low grade to be of any value.

*Table showing the Yield of the * Lake Way Leases.*

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per Ton.	Total		Average rate per ton.
					Gold therefrom.	Ore Crushed.	
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898	West Australian Goldfields Ltd., G.M.L. 162	71.00	61.15	.86			
1899	Do.	1,305.00	607.07	.47			
1900	Do.	1,410.00	560.55	.39			
1901	Do.	..	†9.67	..	2,786.00	1,238.44	.45
1906	Lake Way Leases, G.M.Ls. 162, 163	355.00	215.94	.61			
1907	Do.	275.00	153.66	.56	630.60	369.60	.59
	Total	..	..	..	3,416.00	1,608.04	.47

* Between 1901 and 1906, the returns from these leases are included in the Golden Age Consolidated, Ltd. † From Plates.

The Brothers, G.M.L. 143.—This lease adjoins the Golden Age on the east, the two lines of reef being parallel. As usual, the reef is not continuous but consists of several lenticular bodies of quartz a chain or so apart; the general strike of these is a little north of north-west and they underlie steeply to the west; in thickness varying on the surface from two to ten feet, probably averaging about four or five feet. Even in the apparently continuous bodies of quartz the

BULLETIN Nº 34 PLATE II

The Hon. H. Gregory M.L.A.
Minister for Mines.

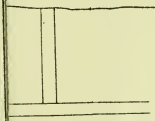
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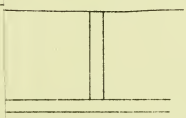
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Nº7, INCLINE SHAFT



Nº10, SHAFT



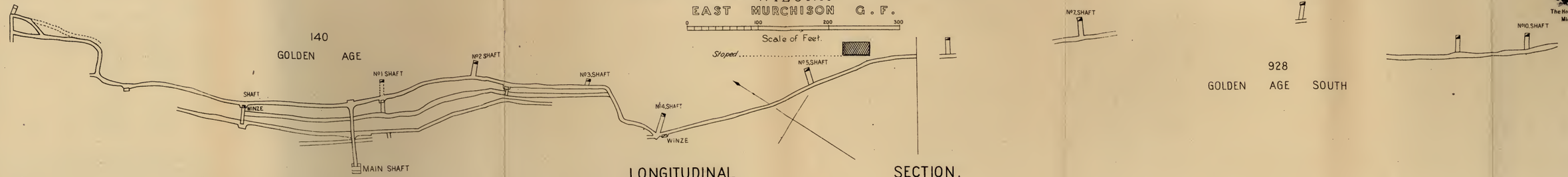
A. Gibb Maitland
Government Geologist.

C. B. Kidson, del.
7. 8. 08.

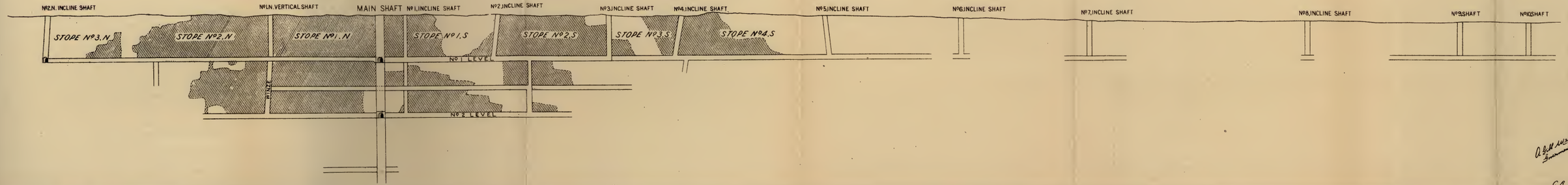
H. J. Pether, Government Lithographer, Perth, W.A.

PLAN & SECTION OF
THE GOLDEN AGE G.M.
WILUNA
EAST MURCHISON G.F.

0 100 200 300
Scale of Feet.



LONGITUDINAL SECTION.



TAKEN FROM MINE PLANS.

The Hon. H. Gregory M.L.A.
Minister for Mines.

A. Bell Assistant Surveyor Geologist

C.B. Kidson, del.
7. 8. 08.

H.J. Pecher, Government Lithographer, Perth, W.A.

lenticular structure of the reef can be seen as, in an old open cut, overlapping lenses of quartz can be seen separated by a few inches of country. A lot of work has been done on this lease, but it has been abandoned for some time and the workings were inaccessible.

Table showing the Yield of the Brothers Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898	The Brothers, G.M.L. 143	91.00	109.72	1.21
1899	Do.	167.00	184.74	1.11
1900	Do.	52.00	71.30	1.37
1901	Do.	358.00	281.13	.79
1902	Do.	159.00	89.44	.56
1903	Do.	44.00	55.98	1.27
1904	Do.	762.00	838.50	1.10
1905	Do.	..	..	..
1906	Do.	1,150.00	867.10	.75
1907	Do.	202.00	213.12	1.05
	Total	**2,985.00**	**2,711.03**	**.90**

Golden Age and *Golden Age South,* G.M.Ls. 140, 928.—A lot of work has been done on these properties, more especially on the former, the extent of which may be seen by a reference to the mine plans herewith (Plate II.), whilst on the latter no work has been done below water level.

The workings on the Golden Age have been abandoned for some time past and were inaccessible, so an inspection of them could not be made. The quartz is here more continuous than is usually the case though the lenticular structure is still present. The main line of reef worked extends through the full length of this lease and also, brokenly, through the south lease; its strike is about north-west and its underlie steeply to the south-west. On the surface the quartz frequently reaches as much as 12 feet in thickness and throughout the main workings it is said to have varied from 3 to 13 feet, averaging about 6 feet. The gold is reported to have occurred in irregular patches and not uniformly through the stone, the bulk of which is too poor to be of any value.

On the Golden Age South lease a small party is working near the surface on a small seam of good stone alongside the main reef; no systematic work is being done however.

Just outside the west boundary of these leases is a very large white quartz reef running parallel to the main line; this reef is frequently as much as 20 feet in thickness and in one place rises as a low hill of quartz to a height of 40 or 50 feet; its northern end is only a few chains north of the Golden Age and from this point it runs south-easterly as a practically continuous body of quartz for a distance of slightly over a mile. No work has been done on t

northern portion of this reef, and it is here apparently non-auriferous; towards the south end a good deal has been done on it on the Emerald Isle, Republic, and Lady Hopetoun leases (G.M.Ls. 693, 644, 252), more especially on the Republic. All these leases are at present abandoned and the workings could not be inspected.

On the surface the reef is of hard white quartz and varies from four to ten feet in thickness. The workings are all above water level and seem to have been of rather an irregular nature, the gold probably occurring in small shoots which have been "rooted" out and the leases then abandoned. All the reefs occur within well defined belts of schists.

Table showing the Yield of the ‡ Golden Age Leases.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.	Total. Ore crushed.	Total. Gold therefrom.	Average rate per ton.
		tons.	ozs.	ozs.	tons.	ozs.	ozs.
1898	Golden Age-Lake Way, Ltd., G.M.L. 140	49.00	123.91	2.53			
1899	Do.	1,302.00	903.96	.69			
1900	Do.	9,066.00	{4,472.59 *964.76	.60			
1901	Do.	2,482.00	1,003.47	.40	12,899.00	7,468.69	.58
1901	Golden Age Consolidated, Ltd., G.M.Ls. 140, 144, 162/3, 164, 241-243, 318, 380, 422, 441, 477, 494-499, 501, 523, 719, T.A. 9, W.R. 33	922.00	3,611.35	3.92			
1902	Do.	13,479.00	5,304.15	.39			
1903	Do.	19,274.00	6,963.93	.36			
1904	Do.	8,846.00	3,118.42	.35			
1905	Do.	..	†752.60	..	42,521.00	19,750.45	.47
1905	Golden Age, G.M.L. 140 ..	398.00	278.13	.70			
1907	Do.	100.00	26.48	.26	498.00	304.61	.61
	Total	..	..	..	**55,918.00**	**27,523.75**	**.49**

* From plates. † By cyanide. ‡ *See also* Lake Way Leases.



A Portion of Lake Way.

*Table showing the Yield of the *Golden Age South Lease.*

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1898	Golden Age South, G.M.L. 139	36.00	5.85	.16
1899	Golden Age South, G.M.L. 380	133.00	270.95	2.04
1905	Golden Age South, G.M.L. 913	78.00	55.13	.71
1906	Do.	495.00	411.60	.83
1907	Golden Age South, G.M.L. 928	479.00	207.57	.43
	Total	**1,221.00**	**951.10**	**.78**

* Between 1899 and 1905 the returns are included in those of the Golden Age Consolidated, Ltd.

Table showing the Yield of the Republic Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904	Republic, G.M.L. 644 ..	402.00	142.88	.36
1905	Do.	14.00	8.00	.57
	Total	**416.00**	**150.88**	**.36**

Essex, G.M.L. 316.—This is another abandoned lease on which a good deal of work has been done. The reef is of much shorter length than most of the quartz reefs of the district and strikes nearly east and west, underlying very steeply south, being almost vertical in places. It appears to have consisted of a lenticular quartz body some four chains in length which has been formed along a well defined fault line which is traceable in the form of a thin zone of crushed rock for some distance both ways; as seen in the surface workings the size of the main ore body has been on the average from three to four feet.

There is also a second small quartz reef on the north side of the main line, on which a little work has been done. This reef outcrops over a length of about five chains and strikes north and south being approximately at right angles to the main line, by which it appears to have at its south end been deflected to the east.

Table showing the Yield of the Essex Lease.

Year.	Name and Number of Lease	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897	Essex, G.M.L. 316 ..	10.00	31.60	3.16
1898	Do.	89.00	134.65	1.51
1899	Do.	223.00	244.07	1.09
1901	Do.	15.00	23.41	1.56
	Total	**337.00**	**433.73**	**1.29**

Lawless, G.M.L. 314.—This is also an old abandoned property. A very large white quartz reef runs through the lease and continues southerly for a total length of about half a mile, outcropping as an almost continuous body of quartz for the whole distance and reaching as much as 20 feet in thickness, probably averaging about six feet. The strike of this reef, which occurs along a well defined belt of schist, is about north-west and south-east and its dip is steeply to the westward.

Lying about a chain to the west of this and within the Lawless lease is a smaller parallel reef on which a little work has been done; this reef outcrops over a length of about eight chains and is from three to four feet in thickness; a little work has been done at the north end of it but this is of no importance.

A fair amount of alluvial (detrital) gold was got over the surface of this lease some years ago, but it has all been worked out and nothing is now being done; the gold was evidently shed from small leaders associated with the big reefs.

Table showing the Yield of the Lawless Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1897	Lawless, G.M.L. 34 ..	10.00	*55.39	5.53
1898	Do.	..	†428.47	
1899	Do.	28.00	11.44	.41
1904	Do.	42.00	7.90	.18
1905	Do.	68.00	9.36	.14
	Total	**148.00**	**‡512.56**	**3.46**

* Include 50.85ozs. dollied. † Dollied. ‡ Includes 479.32ozs. dollied.

All the above leases are working, or have been worked, on quartz reefs. There are several others on which more or less work is being done, but they are not, so far, of much importance.

The following are the principal leases on which "lodes" are being worked:—

Bulletin and *Indicator*, G.M.Ls. 946, 954.—Both of these leases are working on the same line of lode, and the workings on the two properties are connected along the 65 feet level, which is the greatest depth to which any work has been done.

The lode consists of a belt of sheared and shattered greenstone, much foliated in parts, which down as far as opened is very decomposed and weathered; this belt is of very considerable width, being sometimes as much as two chains at the surface and within it are found more or less well defined bodies of ore.

The general trend of the main lode line is about north-east and south-west and its underlie is practically vertical, being if anything steeply to the north-west. It runs from the south boundary of the



A Portion of Lake Way.

Indicator, through the Bulletin and Bulletin North, junctioning near the north-east corner of this latter lease with a second main lode line running about north-north-west and south-south-east through the Red Page and R.M. leases.

The ore body worked in the Bulletin has an average width of three to four feet and has been opened up for a length of about three hundred feet at the 65 feet level but not much stoping has been done. The main shaft is down about 110 feet and good values are said to have been obtained at this depth; no work, however, has been done, beyond sinking the shaft, below the 65 feet level. There are no defined walls to this ore body, operations simply ceasing at a point when values become too low to pay to work; it consists merely of a narrow zone of crushed rock which has been impregnated with gold-bearing solutions, the impregnation continuing for some little distance into the uncrushed country; the values are naturally highest and most concentrated where the crushing has been greatest.

There seems to be every reason for assuming that there should be other similar ore bodies as these crush lines along the main belt of shearing, and a little crosscutting and systematic prospecting would soon prove whether or not such do occur; so far no work of this description has been done on the Bulletin lease. During 1907, 164 tons from this lease were crushed for a yield of 139.47ozs. of gold, being at the rate of 0.85 oz. per ton.

On the Indicator, the same ore body has been worked and has been opened up for a length of about two hundred feet, also at the 65 feet level but not much stoping has been done; its average width in these workings is slightly less than on the Bulletin, and the gold contents are said to be slightly lower. Only about 20 feet of crosscutting has been done westerly on this lease which is for its full length in foliated (crushed) greenstone, all of which is said to carry a little gold; parts of it where the crushing is more pronounced being stated to be fairly good; no development work has been done at any of these bodies, neither have any crushings been reported.

In its nature the ore is the same in both leases, consisting of very soft decomposed and crushed country rock (greenstone) almost free from quartz and therefore sliming to a very great extent in the battery and making very little sand. Being soft the ore is easily worked and above water it stands fairly well but below water it will, without doubt, require heavy timbering until hard country is met with; down to 110 feet (40 feet below water) there is said to be no apparent change. Once settled country is met with the ore bodies will be found to be more regular and defined, consisting of well marked bands of schist (crushed greenstone); the values will probably decrease slightly below the point to which oxidation has reached, but the channels along which the gold occurs should prove permanent in every sense of the word.

On the Bulletin the water level is about 70 feet and the supply is said to be a good one.

Bulletin North, G.M.L. 959.—Very little work has been done on this lease; the main shaft having been sunk to a depth of about 70 feet and a little irregular stoping carried out at this level. Nothing defined in the way of an ore body has so far been opened up, but the deposit is similar to that in the two preceding leases. The schists here are somewhat harder and more unweathered and the crushing and shearing have not been so regular as in the Bulletin, consequently the ore bodies are more irregular; driving along the strike of the schists, however, would probably overcome this irregularity which appears to be merely local and due to certain portions of the country having resisted crushing to a greater extent than others. A yield of 22.73ozs. was obtained during 1907 from 89 tons crushing, which is at the rate of 0.26oz. to the ton.

Red Page, G.M.L. 967.—A similar class of deposit to that in the Bulletin is being worked on this lease, but only a small party is working on it and not much is being done. The ore body, which runs about north-north-west and south-south-east, dipping steeply to the west, is said to be two feet wide and fairly good. It is exactly similar in its mode of occurrence to the Bulletin ore body, and as it occurs along a well defined belt of schists (shear line) systematic prospecting should be well worth carrying out in the hope of picking up similar parallel bodies.

From this lease, during 1907, 197 tons of ore were crushed for a yield of 228.30ozs., being at the rate of 1.16ozs. to the ton.

Moonlight and *Adelaide,* G.M.Ls. 870, 940.—The same line of lode is being worked on both these leases, but all the developments of any importance have been done on the Moonlight.

The lode line runs on a bearing slightly east of the north-east and west of south-west, turning somewhat more south-westerly on the Adelaide, with an underlie at a fairly steep angle to the northward; it consists of the usual belt of crushed and foliated greenstone schists carrying payable gold values along certain fairly well defined lines.

Running through the middle of the lease at right angles to the lode line, *i.e.,* about north-west and south-east, is a second well defined similar belt of schists (shear line) some two chains or more in width. This is the older and main line and can be followed on the surface for a long distance both northerly and southerly from this point; the lode line cuts right through this belt and it is at, or close to, the intersection that the best values are met with.

Along the lode the gold values occur along the lines of greatest crushing and foliation, certain portions which to a greater extent have resisted crushing being almost barren of gold. The extent of the ore bodies is somewhat irregular as the country on both sides of the main lines have to a certain extent become impregnated, and so also along small irregular fracture lines going off from the main

NORTH

TED LTD

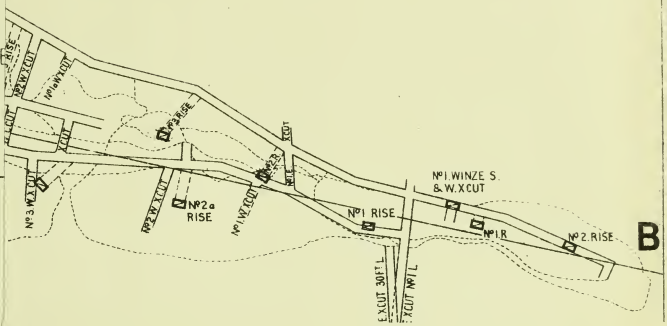
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

The Hon. H Gregory M.L.A
Minister for Mines

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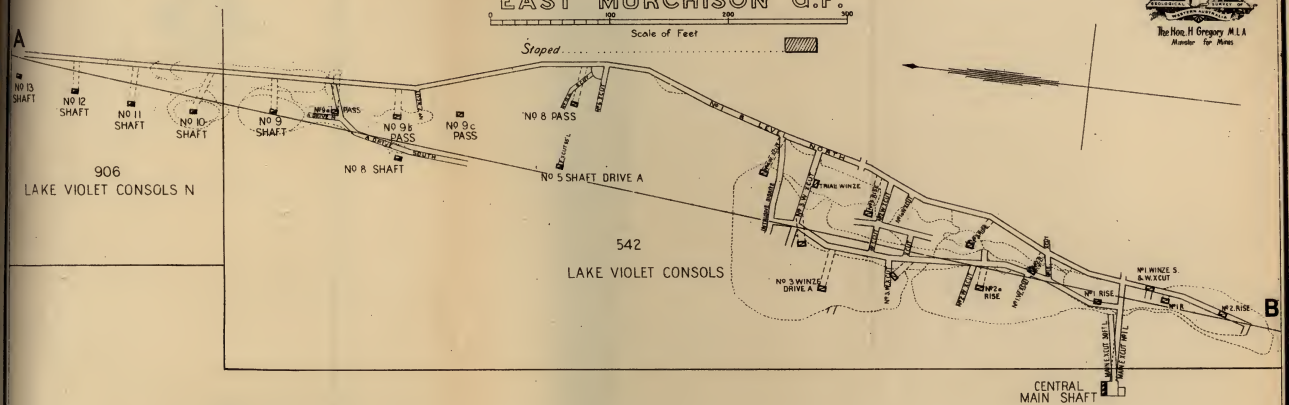
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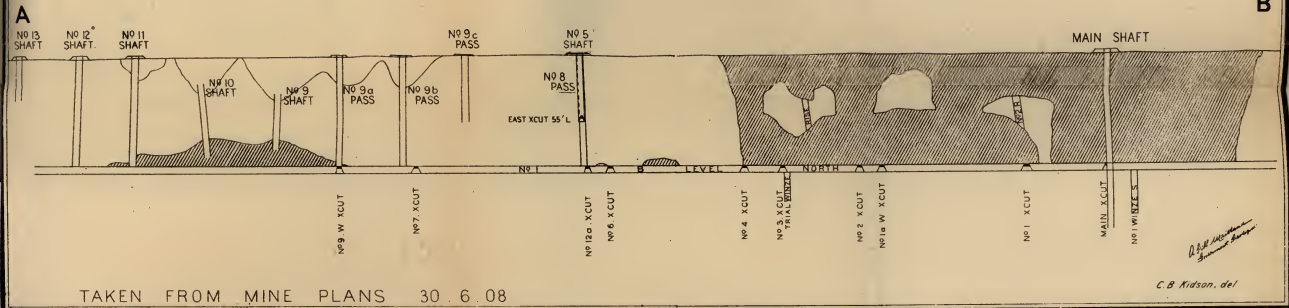
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The Hon. H Gregory M.L.A
Minister for Mines

LONGITUDINAL SECTION



TAKEN FROM MINE PLANS 30.6.08

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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

The Hon. H. Gregory M.L.A.
Minister for Mines

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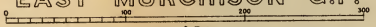
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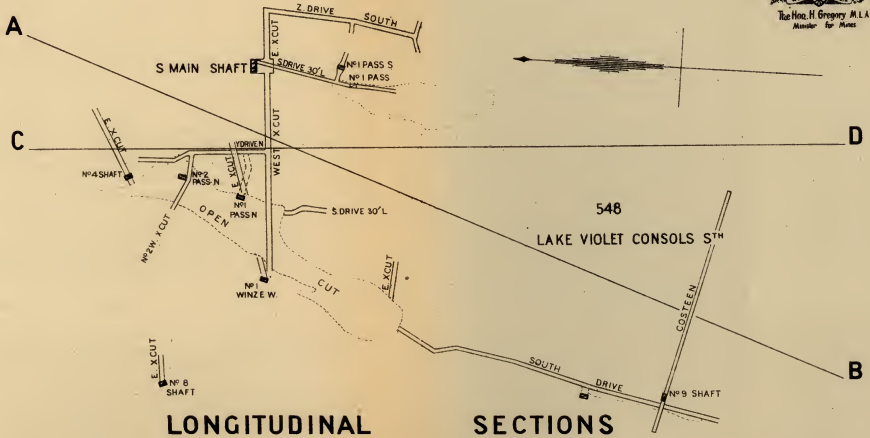
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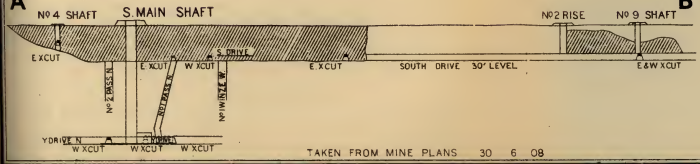




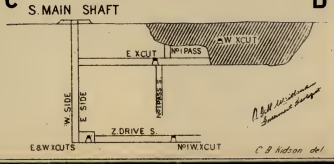


LONGITUDINAL SECTIONS

LOOKING WEST



LOOKING EAST



TAKEN FROM MINE PLANS 30 6 08

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line. Certain small seams carrying values have also been met with along the line of the older (north-westerly) belt of schist, but these have not been opened up to any extent, as practically all the work has been on the other line.

The lode has been opened up at the 70 feet level for a total length of about 350 feet and a little crosscutting has been done, but very little stoping. Work is at present being carried out at the west end at the 70 feet level where the ore body has a maximum width of about ten feet but it is not well defined, and the values are somewhat erratic. This body consists of a zone of rock which has been considerably more crushed and fractured than the enclosing portions, thus having given freer access to gold-bearing solutions. Other similar ore bodies are known to occur throughout the workings but not much has been done on them. The whole of the country within the shear zone, probably as much as two chains in width, carries a little gold but not enough to be payable. Owing to the irregular occurrence of the payable ore bodies the whole deposit needs very careful prospecting and sampling to enable its true value to be determined. The irregularity of the ore bodies will probably cease when settled country is met with as the crushed zones along which they occur will then be better defined and there will not be so much impregnation of the enclosing rock. Just at the intersection of the two main lines of shearing there will however always be a certain amount of irregularity in the occurrence of the ore bodies owing to the broken nature of the country at this point.

So far throughout the workings both the ore and the "country" are very soft and rotten, work being easy on this account, but the country, although standing pretty well above water level, will probably require extensive timbering below. The ore is almost free from quartz and slimes largely during battery treatment.

Small patches or pockets of massive stibnite (sulphide of antimony) are occasionally met with in the workings on this lease, which are small, rarely exceeding a few feet in length, and a foot or so in thickness and can readily be separated from the rest of the ore. These pockets are said to be high in gold values, but so far no effort has been made to treat them.

On the Adelaide, which joins the Moonlight on the south-west, a little work has been done along the same line of lode. The ore bodies here have the same characteristics, being merely narrow zones of more highly crushed rock which have become impregnated with gold.

The workings are only down about 60 feet, and about 100 feet of driving has been done, but no stoping and no crushing have been made to date. No crosscutting has been done, which is absolutely necessary to prove the existence, or otherwise, of parallel ore bodies such as are likely to occur in a deposit of this nature.

Table showing the Yield of the Moonlight Lease.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1905	Moonlight, G.M.L. 870 ..	212.00	95.37	.45
1906	Do.	436.00	156.07	.36
1907	Do.	707.00	351.76	.50
	Total	**1,355.00**	**603.20**	**.45**

Mother of Gwalia, G.M.L. 953.—This lease is situated on the east side of the Adelaide, and on it a little work has been done on a couple of small parallel lode lines running north and south-east; these have been opened up over a width of two or three feet, but no work of any importance has been done on them. A lot of massive stibnite occurs on both lines, and it is apparently this that has been worked as it is said to be highly auriferous.

Gwalia Consolidated, Ltd., G.M.Ls. 149, etc.—A reference to the underground plans herewith (Plate III.) will show the amount of work that has been done on this property.

The lode is similar in nature to that in the Moonlight and Bulletin leases, consisting of a wide belt of crushed and shattered rock carrying in parts payable gold values. It runs almost due north and south, and is very persistent in strike; owing, however, to the *débris* and recent deposits which cover the ground to the northward, it is difficult to trace the line on the surface in this direction, but it probably follows a course as shown on the map. About the centre of the property the main lode appears to be faulted by a large "buck" quartz reef, which runs about north-west and south-east, and can be followed on the surface for a considerable distance (*see* plan). The two portions of the lode to the north and south of this reef are known as the "north" and "south" lodes respectively.

Most of the work has been done on the north lode, which appears to consist of two main crush, or shear, lines separated by about 50 feet of more or less shattered and crushed country rock; these two main lines consist of bands of highly foliated rock, which, owing to their foliation, have given freer access to gold-bearing solutions. Their width varies a good deal, the eastern one, on which most development has been done, having been worked over an average width of about 15 feet, while the western one is a good deal smaller.

As above stated, the country between these two bodies is more or less crushed and shattered (greenstone), and along the fracture lines gold-bearing solutions have had access, and have impregnated it for some distance on either side. Where these cracks and cleavages are most numerous the impregnation has of course been greatest, and the gold values have risen sufficiently high to enable much of the country to be classed as ore. At the north end this impregnation

has been so uniform that the whole of the country between the two main lines (60 feet) has been stoped, and so also at the surface of both the north and south where the whole formation has been mined by means of a large open-cut 60 to 70 feet in width.

Even the main ore bodies are irregular, as they have no defined walls, and there are continually small spurs, or makes, of ore, going off from them; the values also vary a good deal even along the main lines according to the amount of foliation and crushing that has taken place.

On the south lode not so much work has been done as on the northern one, although the deposit here is just as large and, if anything, more irregular, the main line being less defined.

At a depth, when more settled country is met with, the great size and irregularity of these ore bodies will probably decrease, and they will develop into certain well-defined belts of schist (crushed greenstone), along which the gold values will be found. The enclosing country, always more or less shattered, will probably be found to be barren of gold except immediately along small fracture lines.

Although this property has been worked some six or seven years, nothing has been done below the 100 feet level, beyond sinking the main shaft to a depth of about 200 feet, and there is still a very large amount of ore in sight above this; most of the ore milled has been taken from several huge open-cuts carried down to 50 or 60 feet from the surface for a width varying from 20 to 60 feet.

At the north end of the leases a little massive stibnite is found in the lode line; this is in well-defined patches, and does not, as a rule, occur in small quantities throughout the ore, and so does not interfere to any extent in the treatment.

The mine is situated on low-lying country near Lake Violet (Lake Way), and the original water level was about 30 feet, the supply being salt and unlimited.

Table showing the Yield of the Gwalia Consolidated, Ltd.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1902	Gwalia Consolidated, Ltd., G.M.Ls. 149, 170, 316, 516, 524, 540/2, 545/9, 550/1, 569, 906, 930/1, 937, 943/4, 952	11,074.00	4,710.97	.43
1903	Do.	3,843.00	1,562.63	.41
1904	Do.	..	* 3,624.64	..
1905	Do.	16,577.50	6,770.90	.41
1906	Do.	16,278.82	5,330.07	.33
1907	Do.	28,859.00	10,675.90	.37
	Total	**76,632.32**	**32,675.11**	**.43**

* By Cyanide.

Wiluna Queen, G.M.L. 961.—This lease is situated at the extreme south end of the district close to the edge of Lake Violet (Lake Way). A little work has been done on a narrow belt of schist running about north and south, which has been opened up to a depth of about 20 feet, but nothing further has been done. There are three or four feet of lode matter exposed, but the values are said to be very low. The developments up to the present have not been of a very important nature.

Table showing the Yield from Leases at Wiluna, other than those already given, up to the end of 1907.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1907	Big Lode, G.M.L. 976 ..	27.00	9.40	.35
1901	Bonanza, G.M.L. 507 ..	13.00	4.73	.36
1904	Brothers South, G.M.L. 704	54.00	15.03	.28
1904	Clear View, G.M.L. 751	60.00	7.17	.12
1902	Cygnet, G.M.L. 536 ..	79.00	31.35	.40
1907	Dudley Castle, G.M.L. 970	27.50	1.93	.07
1899	Ethelstone, G.M.L. 312 ..	18.00	8.14	.45
1898/9	Federal, G.M.L. 153 ..	135.00	73.55	.55
1904	Federal, G.M.L. 631 ..	166.00	65.68	.39
1901	Fixed Deposit, G.M.L. 531	12.00	8.38	.70
1897	Golden Age North, No. 1 G.M.L. 311	10.00	96.24	9.62
1904	Great Wonder, G.M.L. 740	215.00	89.86	.42
1898	Inverness, G.M.L. 227 ..	37.75	5.16	.14
1906	Kingfisher, G.M.L. 920 ..	49.00	16.85	.34
1904/6	Lady Wiluna, G.M.L. 837	..	*212.94	..
1905/6	Lake View, G.M.L. 905	322.00	93.40	.29
1898	Lake Way Consols, G.M.L. 335	38.00	26.11	.69
1898/9	Lake Way Consols Extended, G.M.L. 342	77.00	116.16	1.51
1902	Lake Way Extended, G.M.L. 589	100.00	104.49	1.05
1898/9	Lake Way Queen, G.M.L. 237	58.00	48.12	.83
1900	Little Wonder, G.M.L. 413	30.00	15.51	.51
1907	Lone Hand, G.M.L. 956	80.50	17.96	.22
1904	Margaret Ewen, G.M.L. 708	140.00	68.10	.49
1905	Margaret Ewen, G.M.L. 871	189.00	114.13	.60
1899	Monarch and Derwent United, G.M.L. 333	10.00	2.95	.29
1898/9	Monarch North, G.M.L. 328	69.00	18.59	.27
1904/6	Moonlight North, G.M.L. 798	597.00	216.30	.36
1900	Off Chance, G.M.L. 403	37.00	16.12	.44
1898	Queen of Lake Way, G.M.L. 157	50.00	21.34	.43
1906/7	Squib, G.M.L. 917 ..	131.00	30.50	.23
1907	White Swan, G.M.L. 980	28.00	7.61	.27
1907	Wild Duck, G.M.L. 990	18.00	8.84	.49
1904/5	Wiluna Star, G.M.L. 730	440.00	205.40	.47
1906	Woodcutter, G.M.L. 911	30.00	17.03	.57
	Sundry Claims ..	1,585.15	912.10	.58
	Total	4,932.90	2,707.17	.54

* By Cyanide.

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GOVERNMENT ASSAYS.

Assays, Analyses, and Determinations of any Western Australian Ore or Rock will be made by the Assayer to the Geological Survey, **when not unduly interfering with official work**, subject to the following conditions:—

1. Each sample must weigh at least 6oz., but not more than 2lbs.
2. Each sample must be enclosed in a separate canvas bag or strong paper wrapper, with a slip of paper bearing the name and address of the sender, together with a private mark by which it may be readily identified.
3. The parcel must be forwarded, **prepaid**, to:—

   The Government Geologist,
   Geological Survey Office,
   Perth.

4. A letter must be sent at the same time to the same address, stating for what metals the samples are to be assayed, or containing other instructions, as the case may be.

(N.B.—It is always advisable to keep duplicate samples of those submitted.)

5. Before any assay is made the prescribed fee must be paid to the Mineralogist and Assayer, or sufficient reasons, in accordance with Section 7 below, be furnished for having the samples treated free of cost.

6. The following fees will be charged:—

	£	s.	d.
(a.) Determination of a Rock or Mineral	0	10	6
(b.) Assay for Lead, Iron, or Manganese, each ..	0	10	6
(c.) Assay for Silver, Copper, or Tin, each ..	0	12	6
(d.) Assay for Gold or Zinc, each	0	15	0
(e.) Dry Assay for Lead, Silver, and Gold ..	1	1	0
(f.) Assay for Antimony, Bismuth, Chromium, Cobalt, Mercury, or Nickel, each	1	11	6
(g.) Proximate Analysis and Calorific Valuation of Coal	1	11	6
(h.) Complete Chemical Analysis of any Mineral or Ore, according to number and nature of determinations .. .. £2 12s. 6d. to	5	5	0
(i.) Other determinations, according to time spent, up to	2	12	6

A reduction of 20 per cent. on the above amounts will be made in favour of any person submitting, in one parcel, five or more samples for identical treatment.

7. With the object of encouraging bonâ fide prospecting, free Assays will be made under the following circumstances:—

(a.) The sample must have been obtained from land within the State not held under lease for mining purposes.
(b.) The exact locality where the sample was found must be disclosed.
(c.) The sample must be of sufficient promise to warrant an assay being made at the expense of the State.
(d.) Free Assays will not be made of samples showing free gold, or of tailings or other metallurgical products, or of umpire samples.

8. The Department reserves to itself the right of refusing to make any particular Assay, and also the right of publishing at any time the results of an Assay made at the public expense.

A. GIBB MAITLAND,
Government Geologist.

By Authority: Fred. Wm. Simpson Government Printer, Perth.

1909.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 35.

GEOLOGICAL REPORT

UPON THE

GOLD & COPPER DEPOSITS

OF THE

PHILLIPS RIVER GOLDFIELD,

BY

HARRY P. WOODWARD,
Assistant Government Geologist,

WITH WHICH IS INCORPORATED A

Description of the Crystalline Rocks of the District,

BY

E. S. SIMPSON and L. GLAUERT.

Issued under the authority of the Hon. H. Gregory, M.L.A., Minister for Mines.

WITH TWO MAPS, EIGHT PLATES, AND SEVEN PHOTOGRAPHS.

PERTH:
BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.

1909.

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PREFATORY NOTE.

The work of examining the Ravensthorpe District of the Phillips River Goldfield was commenced in the middle of the year 1907 by Mr. H. W. B. Talbot, Topographical Surveyor to the Department, who spent several months upon the construction of a feature map upon which contour lines were accurately laid down at intervals of ten feet.

In April of the present year I commenced the Geological examination, but owing to the absence of the Government Geologist, was unable to devote my whole time to it, therefore the mapping of the rock formation was carried out by Mr. Talbot under my supervision and it is only just that I should here pay him the tribute by stating that this work was done in a highly satisfactory manner.

From a geological point of view this district is the most complicated yet examined in this State, and in consequence of exceptional interest, the only point for regret being that these formations could not be observed in their unaltered condition owing to the fact that in only one or two instances have they been penetrated below the ground water level (30 to 100 feet), whilst the deepest mine is only 400 feet and still in the fracture zone.

The report has been divided into three sections, the first consisting of the Geology, etc., from a field point of observation, the second section of the laboratory notes upon the rocks by Messrs. Simpson and Glauert, whilst the third is devoted exclusively to a description of the mines examined upon this and previous occasions. The whole is accompanied by a geological map in two sections, one embracing the western area which includes the Ravensthorpe Mining Centre proper, whilst the other or eastern takes in those of Mt. Desmond and Kundip.

The preparation of a report upon an area that has previously been described by other qualified men is always a difficult and unpleasant duty, for at the best of times opinions must differ, whilst in so complicated a district as Ravensthorpe these are apt to do so more widely; but since both Messrs. Montgomery and Blatchford in putting forward their views, have stated that these were only provisional owing to the lack of a detailed geological map, I feel sure that they will not look upon these points of difference as in any way antagonistic or critical but simply as conclusions arrived at from my own observations under more favourable conditions than they experienced.

HARRY P. WOODWARD.

30th November, 1908. Acting Government Geologist.

PART I.—Introduction.

This Goldfield, which was originally proclaimed in 1900, is situated upon the Southern Coast, its port of Hopetoun being about 150 miles to the eastward of Albany from which there is a weekly mail boat service.

Hopetoun is now connected with Ravensthorpe, the official centre, by a Railway line about 40 miles in length which also serves the mining centres of Kundip and Mt. Desmond.

The portion of this field which has been geologically mapped embraces the whole of the known mining area with the exception of the small centre of West River and Mt. Purchas, which were not considered to be of sufficient importance to be included, since the work entailed would have been very considerable. The area covered by the geological map is about 85 square miles, the whole of which has been also topographically surveyed and contour lines accurately laid down at 10 feet intervals of elevation above the sea level.

The following table gives the rainfall returns as supplied by the Commonwealth Meteorologist:—

	Ravensthorpe	Hopetoun
1902	17.07 ..	18.86
1903	13.60 ..	17.93
1904	19.49 ..	28.20
1905	14.90 ..	17.84
1906	14.78 ..	19.90
1907	11.84 ..	16.07
Mean of 6 years ..	15.28 ..	19.80

PHYSICAL FEATURES.

The main and most striking feature of this district is the Ravensthorpe Range which is visible from the coast; it starts at its southern end upon the eastern side of the township of Kundip, and runs in a generally north-westerly direction for a distance of about nine miles, presenting a bold steep escarpment to the south-west, whilst upon the north-east it is not so precipitous, neither does it present so range-like an appearance since the adjoining plains upon this side are more elevated. It has been described as a horseshoe-shaped range sweeping round from a north-westerly course to a more westerly one, but more correctly speaking it consists of two sections, the southern of which strikes west of north and the northern north of west, whilst between the two a sharp line

of dislocation has taken place at which point it has been cut through by the Cordingup Creek, which flows to the eastward in a steep gorge-like valley. In its southern section the two highest peaks are Mt. Desmond and Mt. Decker which attain an elevation of 1,150 and 1,050 feet respectively, both being conspicuous land marks since they dominate considerably the remainder of the Range.

In the northern section the Range takes a sharp turn and runs upon a more westerly course but although its height is generally greater than the southern portion and it attains an elevation of 1,200 feet above the sea level, it is not so imposing owing to the fact that there are no very conspicuous peaks and the country immediately to the southward is more hilly.

From the first mentioned section in the vicinity of Mt. Desmond a high ridge runs from it in a westerly direction, then sweeping round to the northward rejoins the range in its northern section at a point north of the Floater mine. This ridge forms a basin with the Ravensthorpe Range and divides the watersheds of the Jerdacuttup and its tributaries, which flow to the eastward from the Steere and Phillips Rivers, which flow to the south and west.

This basin-like area is drained by the Cordingup Creek and its principal tributary, the Cattlin Creek, which flow over large and rich alluvial flats uniting near the site of the old smelting works below which the combined streams flow in a gorge-like channel through the Range in an easterly direction, upon the north-eastern side of which it junctions with the Jerdacuttup River.

The western area of this map is drained by the Annabelle and Stevenson Creeks, which flow in a southerly direction, and the south-western portion by the Manyutup Creek flowing in a westerly direction, all of which are tributaries of the Phillips River.

The district between Mt. Desmond and Kundip is drained by the Steere and Western Steere Rivers, the former of which rises near the Elverdton mine and flows in a southerly direction along the foot of the Ravensthorpe Range, being fed by numerous water courses which join it both from the east and west.

The Western Steere rises to the south-west of the Elverdton mine and follows a course approximately parallel with the Steere River, with which it unites to the southward of the area covered by the map.

Between the Cordingup and the Cattlin Creeks there are some extensive and rich alluvial flats covered with gum trees of considerable size, but elsewhere the country is rough or undulating, being broken by numerous gullies.

With the exception of the granite and elevated sand plain areas, which are only covered by low stunted vegetation, the ridges and gullies are densely covered with mallee intertwined with creepers, which are a great hindrance to a person walking off the tracks. The soil of the large flat, as well as the greenstone area in the north-western section of the map, is a rich red or dark brown



Photo. H. W. B. Talbot. Neg. 413.

The Ravensthorpe Range, with Mt. Chester tunnel.

clay admirably suitable for wheat-growing, whilst the granite area, with the exception of some dark and light clay patches, is of a poor sandy character similar to that of the elevated sand plains.

The underground water supply has proved to be plentiful, but invariably salt or slightly brackish at best, the latter being generally of an alkaline nature and met with in the granite area.

GEOLOGY.

A transient glance at the geologically coloured map will at once convey to the observer the intricate character of the dyke system and the variety of rocks exposed at the surface within this limited area, but only a slight idea of the complex character presented by the crystalline series in this district can be formed even when it is stated that these belts and patches of colour with one symbol as representative of one class of rocks are in reality very often further intersected by numerous minor dykes or veins of too small a size or of too great a similarity in their weathered state to be mapped in.

Besides the complex of crystalline rocks exposed, a further series of what may possibly be old and highly metamorphic sedimentary are also represented followed in ascending order by a more modern although probably fairly ancient series of sandstones, quartzites, and conglomerates, whilst further to complicate matters considerable tracts of the surface are covered by superficial deposits of clay or sand which for the most part effectually conceal the nature of the underlying rocks, although the general character of these may often be approximately arrived at by examining the composition of the weathered superincumbent material.

No geological age can be assigned to any one of the formations or groups of rocks in this district owing to the fact that organic remains by which such points are determined have not as yet been discovered, whilst should fossils be discovered in the sandstone series (which is the only possible one) no great advances in this direction will be made, since these beds are the most modern in the area.

Generally speaking, the north-western section or greenstone area is covered with clay, therefore no rocks are visible, their character being determined by the nature of the soil and work done by prospectors; in the central section however, the rocks outcrop in a practically unaltered condition and although of considerable complexity they are most easily determined and mapped in. In the range sections upon the other hand the whole series, although outcropping, is so highly altered even to depths of close upon 100 feet that it is quite impossible to determine with accuracy their true character, they are further complicated by a series of parallel interfoliated ferruginous lode-like bodies of a lateritic character.

In the following description these rocks have been divided into groups, the first, probably the oldest constituting the

Ravensthorpe Range, after which the series is called, consist of weathered basic schists and serpentines, the former of which are intersected by numerous parallel ferruginous bodies and ferruginous banded quartzite reefs and often capped by laterite whilst the latter is usually covered by a superficial deposit of magnesite.

The second series are the granites with their intersecting dykes of diabase, diorite, quartz diorite and kersantite, in the schistose portion of which many of the copper dykes are situated, whilst others lie at its contact with the greenstones.

The greenstone series next being apparently the magnetic nucleus from which the basic dykes referred to above radiated into the granite. This series is intersected by pegmatite, felsite, quartz diorite, and camptonite dykes. Following in ascending order are the Kundip series of sandstones, which must have at one time covered a considerable portion of this area, since small outliers and detrital material occur at places all over it. They are of interest in so far that they are the only distinctly stratified rocks of the district.

The superficial, travertine, laterite, and alluvium are of little interest but the lodes which are treated separately are extremely so, the great drawback being the very limited extent of the workings, particularly in depth, which precludes the possibility of so thorough an investigation into their character as could be desired.

Ravensthorpe Range Series.—Probably the oldest series of rocks in this district are the highly weathered and altered schists which form the Ravensthorpe Range, but notwithstanding the fact that they rise to a considerable elevation and have been cut through by the Cordingup Creek, at no point are they exposed in an unaltered state.

These rocks at their outcrop are of a light brownish colour and consist of kaolin, silica, and iron, the latter being in the form of limonite (hydrated oxide of iron); they have a marked lamination which runs in a north-westerly direction identical with that of the Range and are traversed by numerous parallel lode-like bodies of iron ore and a series of banded quartzite veins of considerable size and great longitudinal extent.

These ironstone bodies have been quarried at one or two points for flux for the local smelters, but so far as tested they have proved to be of a comparatively superficial character; a shaft at the Iron Knob sunk to a depth of about 70 feet did not pass through anything but kaolinised rock containing small veins of oxide of iron. At one or two points copper stains have been observed, but so far no appreciable quantity of the ores of this metal; their occurrence has, however, been interpreted as indicating that these ferruginous bodies are the gossans or iron caps of copper lodes.

Upon a lease called the Mt. Chester, situated close to Mt. Desmond, one of these bodies is replaced for a length of about 250 yards by a manganese (pyrolusite and psilomelane) lode which at a



Photo. H. W. B. Talbot. Neg. 415.

The Iron Knob
(Ironstone flux quarry.)

point where it was cross-cut at the surface measured 20 feet in width.

With the object of testing this lode at a depth an adit level was driven for a distance of 424 feet into the steep hill face 90 feet below the outcrop. This is of considerable interest since it is one of the few points at which this series may be examined, otherwise than at the surface. The rocks in this drive present a well-marked schistose structure, the strike of the folii being north-westerly with an inclination of from 70 to 75 degrees to the south-westward. They are mostly white, light yellow or grey in colour and highly kaolinized but less hard than at their outcrop since the cementing oxide of iron is absent, it having segregated into the leaching channels.

A specimen [7828] from this drive exhibits a banded structure which varies in colour from grey to yellowish white, the whole being pitted by small cavities representing casts of marcasite (white iron pyrites) all trace of which mineral has been entirely removed.

In this drive no ferruginous body of any size was cut notwithstanding the fact that between its mouth and the manganese lode outcrop at the surface a large one is exposed; this appears to be conclusive evidence that they are of no vertical extent.

The Mt. Decker tunnel which is close by is also of interest, but not nearly so much since it has been driven in the direction of the rock laminations, therefore little variation in its character occurs; neither does it throw any light upon the nature of the ferruginous bodies.

At the southern end of this belt of rocks a considerable amount of work has been done upon them in the Gem and Two Boys leases, but owing to the nearly horizontal lie of the formations, only a moderate vertical depth has been attained, therefore those encountered are still of a highly altered character, being white and almost pure kaolin near the surface, whilst at the lowest levels they pass into undoubted greenstone schist in a very much weathered condition.

Owing to the elevated position occupied by this apparently old land surface the changes wrought by oxidation, hydration, and subsequent leaching upon this series, which have extended over a considerable period of geological time, have so completely altered their character to a greater depth than at present explored that it is impossible to state with any degree of confidence what their origin may have been, both Mr. Montgomery and Mr. Blatchford lean towards the metamorphic sedimentary theory; whilst the former authority has made further the suggestion that the ironstone gossan-like bodies may possibly be the caps of interbedded cupriferous lodes.

If this sedimentary origin theory is the correct one these rocks must, previous to their leaching, have been altered by heat into

greenstone, in which case during this metamorphism the iron in the form of pyrites must have segregated to a very considerable extent into parallel belts or zones following the induced foliation which may or may not have been in uniformity with the original bedding.

A careful examination however, made under more favourable conditions than were possible for former observers, leads to the conclusion that the rocks comprising this range are of igneous origin and are of a similar greenstone type to those met with upon the goldfields generally. This is further supported by the occurrence of a belt of magnesite capped serpentine in the centre of and following the same direction as the range, which rock from its petrological character is clearly an alteration of the hornblende series.

The parallel ferruginous bodies which intersect this entire series with the exception of the serpentine have in no instance exhibited any of the recognised characteristics of fissure lodes, for neither do they possess the marked definition usually noticeable between lode formation and country rock nor, so far as tested, have they proved to be of any vertical extent. In composition at the surface they are identical with the laterite deposits which cover and cap a considerable extent of these ranges and in consequence they are most probably of similar origin, their parallel character and continuity being due either to the superior capillarity of certain belts of schists which have allowed of the ascension of ferrous solution or to the fact that a series of highly basic ferro-magnesian dykes have been intruded along the foliation planes of the primary greenstone schists, whilst the weathering of their outcrops has yielded belts of highly ferruginous laterite.

In support of the basic dyke theory, a reference to the map will at once demonstrate the fact that the course assumed by these parallel ferruginous bodies is in general uniformity with that of the basic dykes in the granite area which lies immediately to the westward, certain irregularity in these latter being due to the character of the rocks since in a schistose series it is only natural that dykes should assume a greater degree of parallelism in conformity with the foliation than in a more massive crystalline rock-like granite.

The conclusion arrived at is that these ferruginous bodies are not lodes but simply laterite cappings which follow the outcrop of a series of ferro-magnesian dykes whilst the enclosing rocks or country are altered greenstone schists of probable igneous origin.

Besides the ferruginous dykes referred to above there are a series of banded ferruginous quartzites (jasper in part) identical with those met with upon the Eastern Goldfields. These are of even greater longitudinal extent than the more basic series and are apparently of very considerable antiquity since the boulder and pebble conglomerate beds met with near Kundip are very largely composed of them.



Photo. H. W. B. Talbot. Neg. 414.

Showing peculiar weathering of Banded Quartzite.

They in all probability represent shearing lines since they have a course parallel to that of the foliation of the schists the banded structure being due to the gradual deposition from ascending mineral solutions as the fissure slowly opened owing to the contraction of the rocks in the process of cooling, the layers of differing material being due to varying composition of the depositing solutions over a long period. Up to the present bodies of this character have nowhere proved to be of any direct economic value in this State but that they have played a hand in the deposition of gold is proved by the fact that where they have intersected auriferous veins the latter are of much greater value in their immediate proximity.

The whole of the area occupied by these rocks is densely covered with scrubby vegetation, whilst considerable tracts upon the elevated portions are capped by sheets of laterite.

The Granitic Series.—Under this heading are included the intrusive granites and intersecting basic dykes which occupy a central and southern portion of the area covered by the map between the Range and the township and to the southward of the latter. They are in all probability a portion of the series met with upon the southern coast which extend from the Warren River upon the west to Israelite Bay upon the east.

These rocks for the most part outcrop at the surface in a practically unweathered condition, therefore owing to the scarcity of soil only scant herbage of a hard scrubby nature is able to exist and in consequence their mapping is made exceedingly easy. At one or two points however the decomposition of this rock has yielded a white or dark grey clay upon the latter of which timber of considerable size or patches of dense mallee often flourish.

Extensive tracts of superficial deposits of sand are also met with in places which completely mask the character of the underlying rocks, but from the nature of these deposits it may be inferred that they were primarily derived from the weathering of the granites although possibly at a subsequent period they formed the sandstones of the Kundip series.

There are also considerable tracts of alluvium which are particularly well developed in the basin-like area drained by the Cordingup Creek, which were originally covered by fine salmon gum timber, but this has to a very great extent now been cut down either for mining purposes, for fuel requirements, or with the object of clearing the land for farming since the soil is of a very high quality.

These granites belong to the soda-lime felspar group, and vary very considerably in character and composition from fine-grained compact rocks to very coarsely crystalline ones whilst they sometimes contain considerable quantities of hornblende, particularly when in the proximity of basic dykes.

The whole of this area has been shattered by the basic intrusions to the north-west from which magma numerous greenstone

dykes and masses diverge intersecting the granites in a general south-easterly direction with a degree of parallelism that is remarkable.

These dykes consist for the most part of diorite or amphibolite possibly resulting from the alteration of diabase, which rock is exposed at one or two points in the form of dykes having an east and west or north-easterly course cutting through the normal greenstones and therefore of probably more recent origin. Besides the diabase there are a series of large quartz diorite dykes which break through all the others in a north-easterly direction; these, near the Elverdton mine and to the southward of it, are well developed and of very considerable size, whilst this class of rock is only represented by one or two quite small dykes in the Ravensthorpe section of the map.

Besides the dykes which attain sufficient dimensions to be mapped in there are belts of country particularly in the contact zone, in which the basic veins are so small and so numerous that in some cases hand specimens exhibit these whilst further the majority of the copper lodes are also greenstone dykes situated at or near the contact, but these will be more fully described later on.

Fringing the eastern edge of this area and abutting on to the southern section of the range, in the locality of the Elverdton mine, is a belt of schistose granite, the foliation of which follows the prevailing northerly trend, and this class of rock contains some of the best defined and richest cupriferous dykes of the district.

In the granite area the basic dykes are very easily traced by the character of the vegetation, the rich red soil derived from the weathering of the latter, supporting a much more luxurious growth than the poor sandy soil of the granite area. In other places where less weathered rocks are met with at the surface, the dyke appears like dark bands which can be traced without any difficulty. At one or two places there are what appear to be fault lines crossing the dykes; if this is the case the displacement must have been very considerable, in fact rather too much so, to be a fact, therefore, the more probable solution of this phenomenon is that the dyke fissures have suddenly terminated abruptly upon shearing planes. There is very little doubt but that considerable faulting has taken place, an instance of which, on a minor scale, is visible in the Elverdton mine, whilst the gap in the range, through which the Cordingup creek flows, is also one of them upon a larger scale.

The Greenstone Series.—This series of rocks occupies the extreme north-western portion of the area geologically mapped, beyond which they extend according to Mr. Blatchford in a comparatively narrow belt for a distance of about 12 miles in the direction of Cocanarup.

Most of this greenstone area is covered with a layer of from two to six feet in thickness of red loam or clay, which completely masks the character of the rocks, therefore, with the exception of those



Photo. H. W. B. Talbot. Neg. 417.

A Greenstone Dyke traversing granite country.

points at which these superficial deposits have been penetrated either by shafts or trenches, their nature can only be surmised.

It is, apparently, a magmatic intrusion from which off-shoots have penetrated and shattered the granite in a south-easterly direction, the massive greenstones themselves have also proved to be intruded by dykes of quartz-diorite, camptonite, kersantyle, pegmatite and felsite, whilst the quartz reefs which were worked for gold in the shallow ground passed into basic dykes at a depth.

This area was originally densely covered with mallee scrub, in which belts of good timebr were occasionally met with, the whole being usually much matted with creepers, which adds to the difficulty of its examination, whilst all positions must be fixed by traverse.

In and around Ravensthorpe the principal copper lodes are contained in large off-shoots of this rock, or at its contact with the granite, whilst at Kundip a mass of considerable extent also encloses the lodes.

The Kundip Series.—This series of rocks, which are most largely developed near the township of the abovenamed, consist principally of sandstone (often ferruginous), grits, quartzites (ripple marked) and conglomerate. They are, undoubtedly, of marine shallow water origin, their deposition taking place at a period when the existing Ravensthorpe range formed the coast line, since high up its flank are boulder beds, composed of water worn masses derived from the banded ferruginous quartzite reefs; these beds further from the range pass first into pebble conglomerates and then into quartzites, the latter being often of so white a character as to be mistaken for quartz.

In the northern section of this area this series is only represented by a few small isolated patches of highly ferruginous sandstone, these being the only remaining evidence of the once considerable horizontal extent of these beds.

Near the Explosives Reserve one of these small outliers occupies so peculiar a position that at one time considerable doubt existed as to its origin since in its general character it presents a striking resemblance to a dyke; however upon a careful microscopic examination of the rock it proves to be a ferruginous sandstone, and therefore must have resulted from the infilling of an open fissure with sand from the surface.

The sand plains or superficial deposits probably also belong to this series, the sand of which they are composed being due to the weathering of soft sandstone.

The age of these beds is uncertain, since owing to their shallow water origin the wave action would have destroyed all traces of organic remains, but is is highly probable that they belong to the Great Australian Bight series (classed as Tertiary), which extend along the south coast from the westward of Albany far into South Australia.

The Lodes.—So very little work has as yet been performed upon the lodes of this district, and this little with the exception of one or two mines, is confined to the zone above the ground water level, that it is premature to make a definite statement as to what the permanent character of these bodies will be at a depth.

They may, however, be provisionally divided into two groups or classes of distinct type, the first of which are basic cupriferous dykes, and the second are apparently siliceous and ferruginous deposits filling leaching channels along the rock jointing, and therefore give less promise of permanency.

Without exception, all the mining upon this field has been confined to the fracture zone, and with only one or two exceptions to that portion of it which is situated above the permanent ground level which may be called the zone of aeration, whilst that below may be termed in contra-distinction the zone of saturation, and since no mining has been carried on in the zone of cementation which would here be represented by the lower section of the saturated zone and the waterless ground beneath it.

In this district the passage from the zone of aeration to that of saturation does not appear to have produced that marked physical change in the character of the lode and ore which is so usually met with and expected, since unaltered rocks containing the primary sulphides occur at a considerable elevation above the ground water level, and even in some cases quite near the surface; therefore it will be better to discard the above classification, substituting that which adapts itself more closely to these local conditions, viz., into the oxide and sulphide zone, the former of which covers that portion of the lode in which oxidation, hydration, and weathering have taken place, and the latter that in which the rocks in an unaltered form carry primary sulphides.

The question of primary sulphides occurring above the ground water level has been carefully investigated, and the only solution which can be arrived at is that the great density and impermeable character of the rock matrix have resisted weathering, and thus protected the enclosed ore from the oxidising influence of the descending aerated water.

The lodes at the surface present all the characteristics which are usually associated with deposits of copper ore, viz., ferruginous gossan outcrops (iron hat) of often considerable size and usually highly siliceous, the only indication of copper when present being minute traces of green carbonate.

These quartz and gossan outcrops usually carry fairly high gold and silver values, so much so in many instances as to cause them to be classed as auriferous lodes, whilst copper if present occurs in such small quantities as to be of quite a secondary consideration.

In prospecting these outcrops in order to ascertain their copper values it has been necessary, in many cases, to sink to as great depth as 40 feet before payable ore was encountered, when it most usually consisted of a ferruginous mixture of both oxides and car-



Photo. H. W. B. Talbot. Neg. 409.

White Quartzite Cliffs near Kundip.

bonates (liver colour ore) with small green crystals of malachite contained in the cavities.

In this upper portion of the lode the ore occurs in bonanza-like enrichments either in a bunch-like form within the main body or more commonly in flat lenses upon one or the other of the walls. These have been called shoots by the miners, but since they are of purely secondary origin, and lack vertical continuity, this term has been decidedly incorrectly applied. The matrix or "formation," as it is usually called near the surface, consists of soft brownish clay which passes imperceptibly into weathered mica schist, then into schistose greenstone, and eventually into a solid basic dyke stone. Quartz is fairly plentiful in the zone of weathering, but below it mostly occurs in veins or layers which give the lode a banded appearance.

Both the gold and silver appear to be principally associated with the ironstone and quartz, a lesser quantity being carried in the copper ore whilst the percentage of these precious metals, particularly the gold, shows a marked decrease downwards in the lode.

The transition from the oxidised to the sulphide ores is usually sudden, there being no rich oxides and native copper capping a zone of secondary sulphide enrichment, but directly the solid rock is encountered, chalcopyrite occurs usually coated with green carbonate or more rarely coverite.

In the sulphide zone the chalcopyrite is associated with pyrites, marcasite and pyrrhotite (the latter largely predominating in the Cattlin mine), disseminated through the entire dyke mass or occasionally as lenses or pipes of ore upon one or the other wall of the formation.

In the unaltered sulphide zone there is an appreciable falling off in the gold and silver values, whilst a further steady reduction takes place even within this zone level by level downwards, thus clearly indicating that the higher values in the oxidised zone, and the upper portion of the sulphide zone are solely due to concentration, and to the deposition of gold from alkaline sulphide solutions.

Quartz too is largely a secondary mineral being deposited as metasomatic action has taken place in the lode channel, this being clearly demonstrated in nearly all the mines since lodes consisting almost entirely of quartz and ferruginous gossan at the surface pass into massive greenstone often almost destitute of quartz at a depth. The proportion of iron has also considerably increased near the surface, owing to its deposition from ascending solutions drawn to the surface by capillary action.

The fairly concentrated bunches of copper ore in the oxidised zone are evidence that secondary enrichment has taken place whilst the barren iron caps also indicate a leached zone, as however, no secondary sulphide enrichments occur, these bonanzas cannot as is usually the case have been derived from their oxidation. It is probable, therefore, that the carbonates and oxides of copper have

leached out of the lode cap by descending meteoric waters charged with organic acids, and subsequently redeposited as carbonates and oxides at a lower level when their solutions came in contact with the alkaline salts which the surrounding granitic rock contains in large quantities.

This alkalinity of the rocks, and in consequence that also of the ground waters has probably played an important part in the prevention of the deposition of secondary sulphide, since such water would immediately neutralize all acid solutions formed from the decomposition of the primary sulphides, and convert the copper directly into carbonates (as demonstrated by the carbonate coated chalcopyrite) therefore at the ground water level no acid solutions could be present from which copper could be deposited as a secondary sulphide upon coming in contact with chalcopyrite or marcasite.

As previously mentioned, traces of covellite are sometimes present coating the chalcopyrite, but since these are usually only met with along the lines of fracture it would appear that at these points a preponderance of acid must have been liberated owing to the more rapid decomposition of the ore, thus producing conditions favourable to the deposition of secondary sulphides.

At the deepest points of the richest mines the ore usually has a foliated structure, consisting of bands of quartz, greenstone, and chalcopyrite, or one of the iron sulphides, which layers do not occur with that ribbon-like regularity characteristic of many ore bodies in which the mineral matter has been deposited, layer by layer, from solution upon the sides of an open fissure, but of that lenticular form peculiar to schists, while the poorer portions consist more largely of greenstone schist containing only disseminated sulphides. Besides these two forms, as before mentioned, sheet-like lenses of variable size and richness (called shoots) are of common occurrence, forming upon either one of the walls; whilst extending from these into the adjoining wall rock (which is often granite) as well as into the formation itself are disseminations of ore, which apparently indicate that these rich bodies are due to metasomatic action, subsequent to the deposition of the cupriferous dyke.

Exactly under what conditions these were formed it is difficult to determine, since it is usually acknowledged that chalcopyrite is a primary sulphide, whilst these bodies decidedly present all the characteristics common to secondary or replaced deposits.

There are authentic instances in which chalcopyrite has replaced certain organic substances, and since marcasite is commonly of secondary origin there seems to be no reason why it should be necessary to wait until chemists decide the exact reactions that have taken place before a fact can be admitted. That chalcopyrite does occur, both as a secondary as well as a primary mineral, there can be little doubt, since large and rich bodies of this class of ore are usually met with immediately below the secondary sulphides, whereas comparatively lean ore only is often found to immediately follow it as greater



Photo. H. W. B. Talbot. Neg. 411.

Basal beds of the Kundip series, Western Steere River.

depths are reached, or in other words, that the upper portion of a lode, after the so-called primary sulphides are encountered, is invariably richer than the zone below it, although no copper ore other than chalcopyrite be present.

One point of particular interest with regard to secondary enrichment is noticeable upon this field in those lodes which cross the foliation of the rocks, the richer portions in which being apparently governed by the character of the country rock at the point of intersection, thus we find these zones of enrichment tilted upon the fissure plane at an angle coincident with the inclination of the rock folii, which give them a definite shoot-like appearance, whilst the intervening sections in the lode may be either barren or carry only gold values. In some instances the cupriferous sections have appeared to turn off from the main fissure on to the planes of foliation, or to put it the other way round, lodes which at their outcrops appear to follow the foliation of the rocks are found at a depth to swing round on to the main fissure plane, a good instance of which is exhibited in what is known as the "ironcap lode" in the Flag mine, in which the ferruginous gossan outcrop has a course of north-west and south-east, with a dip to the north-east; this at the 70ft. level has a course east and west, with a dip to the south and tilt to the east, *i.e.*, the intersection of the planes. Similar occurrences probably will be met with at one or two other points in the same mine, one of which is called the "eastern leg," but in this case the ore pipe has left the intersection of the planes and followed the foliation to the north-east, whilst the point of intersection of the two could not be examined since it is situated further to the eastward than the present end of the 100ft. level.

It is apparent that a main east and west fissure has intersected a series of normal north-westerly low-grade cupriferous dykes, from which it has been enriched at the point of intersection, and since a considerable portion of the high grade ore that has been obtained from this mine came from veins having a north-westerly course, it is probable that the main lode, the course of which is south of east, is not cupriferous in a primary sense, but has simply been fed at certain definite points called shoots.

As previously stated, a large number of these lodes may more correctly be described as auriferous than cupriferous, owing to the greater value in gold; in some instances, these, as before described, make into copper lodes at a depth with greatly diminished gold values, but there are also a series which lie in the greenstone area to the north-west corner of the map, which although undoubtedly of the same character as the others have proved when the gold practically gave out to carry too low copper values at their lowest levels to be payable.

These lodes are very highly siliceous near the surface, in fact they may be termed quartz reefs or ferruginous quartz reefs, according to the quantity of iron gossan contained. With depth, however,

they assume the usual schistose character, and are often heavily charged with marcasite, and also carry a little copper, whilst deeper still they assume a more basic character, with in places almost a disappearance of quartz. They were worked entirely for gold, some giving very considerable promise when first discovered, but the so-called shoots were short and values fell so rapidly that they are now practically abandoned.

The conclusions drawn are that those cupriferous dykes, which are of sufficient size to warrant deep mining, will prove when the fracture zone is passed to consist entirely of highly basic rock, through which iron and copper sulphides are disseminated, whilst quartz will have almost entirely disappeared and the gold and silver only in practically negligible quantities.

Of the other class of ore body there is little to be said, as they are simply leaching channels which follow the joins in a perfectly kaolinized schistose rock, so altered is this rock that 40 feet were sunk in it by the original prospectors to the vein, under the supposition that it was alluvium. They consist of a belt of kaolinised rock intersected by a series of veins of ferruginous quartz radiating from a main one, the whole of which is often auriferous. They have little inclination, starting from an anticlinal fold, at the apex of which it was small, but very rich stone was obtained at the lower levels. Values are rapidly falling, and will probably shortly become too low to be payable; it is possible, however, that others will be found occupying positions below the ones at present being worked.

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PART II.—Description of the Crystalline Rocks of the Phillips River District.

By E. S. Simpson and L. Glauert.

A most varied and interesting series of igneous rocks is represented in the collections of Messrs. Woodward, Montgomery, Blatchford, and Talbot. They range from a normally acid granite through intermediate types to a serpentine, and the study of them is complicated by the large development of hornblende and plagioclase not only in the amphibolites and intermediate rocks but also in the granites, and by the varying texture exhibited by one and the same rock.

GRANITIC ROCKS.

Soda-Granite.—The granite of this district is of an unusual type being almost devoid of orthoclase, the place of which is taken by a soda felspar. Its chemical composition is shown by analyses of [8139] and [8151].

	[8139] Well 25 chs. S. of No. 2 Tank, Ravensthorpe.	[8151] Western Well on W.R. 7517, Ravensthorpe.	Saganaga Lake, Minnesota.
SiO_2	70.27	68.11	69.34
TiO_2	.12	.74	*n. d.*
CO_2	.20	.21	*n. d.*
P_2O_5	.12	.28	*n. d.*
H_2O combined	1.08	.86	1.17
K_2O	.64	.76	.71
Na_2O	4.64	4.58	4.33
CaO	1.76	3.79	3.43
MgO	1.87	1.75	1.18
MnO	.20	.16	*n. d.*
FeO	1.22	2.99	*n. d.*
Fe_2O_3	.97	.11	2.46
Al_2O_3	16.11	15.77	17.25
FeS_2	.09	.17	*n. d.*
H_2O hygroscopic	.10	.11	*n. d.*
	99.39	100.39	99.87
Sp. gr.	2.70	2.74	*n. d.*

The most noticeable features of these analyses are the small percentage of potash and large percentage of soda, and the unusually high percentage of alumina. This latter is interesting as explaining the occurrence of andalusite in the granitic schists. The closest approach to this rock in chemical composition that we can find is the Granite (Amadorose) of Saganaga Lake, Minnesota, the analysis of which is quoted above.

In hand specimens the rock is light grey to dark grey or green in colour, and in texture and appearance varies from that of a typical coarse grained granite [8151] and [8332] to that of a medium or fine grained diorite [8147] and [8318]. In some specimens, notably [1875] and [8147], the hornblende crystals are large and very clearly defined.

Under the microscope quartz is found to be an important constituent in all cases and would appear to be the final product of crystallisation. Plagioclase and deep green hornblende are both very plentiful, the latter largely idiomorphic and evidently the first of the main constituents to crystallise out of the magma. Some ilmenite and biotite occur in nearly all examples, whilst zircon and apatite are seen in some of the sections.

Quartz-Ceratophyre.— Acidic dykes do not appear to be plentiful, but undoubtedly fine grained offshoots from the soda-granite are represented in [8315, 8364, 8553, 7825]. Surface specimens of this rock are pale grey in colour, but a specimen [8553] from a depth of 400 feet in the Mt. Cattlin Mine is very dark grey. It has a specific gravity of 2.68 and contains 71.01 per cent. silica, 0.55 per cent. potash, and 5.36 per cent. soda. These rocks are all very close-grained with occasional phenocrysts of felspar and quartz.

Albite Pegmatite. —Some very interesting specimens of a very coarse-grained pegmatite have been collected. The chief constituent of this rock is albite, both granular and very coarsely crystallised. In places it is of a pale bluish green colour. Some of this mineral with a coarsely lamellar structure was analysed, with the results given below.

Associated with the albite are coarsely crystalline spodumene (see analysis below), pink and green tourmaline, muscovite, lepidolite and quartz. See specimens [1863, 8347, 8487, 8488].

Analyses of Spodumene and Albite.

	Spodumene.	Albite.
SiO_2	61.94	69.13
Al_2O_3	26.48	19.44
FeO	1.82	*Nil*
MnO	trace	trace
CaO	.28	*Nil*
Li_2O	7.02	*Nil*
Na_2O	1.93	10.83
K_2O	.47	.04
H_2O combined	.29	.17
	100.23	99.61
Sp. gr.	3.14	2.63

Two miles south-west of Cocanarup is a pegmatite which is in places a typical graphic intergrowth of felspar and quartz [1855], in others exhibits much muscovite or lepidolite [1859, 1861].

Andalusite Schist.— Two specimens of rock [8463] and [7827] are composed mainly of a fine grained base of sericite in which are embedded numerous crystals of andalusite. These, and a foliated hornstone [8143] largely composed of andalusite, are evidently alteration products of the soda-granites.

Mica-Chlorite Schist.—In places, as the result of the crushing of the soda granite, accompanied by development of sericitic mica at the expense of felspar, and chlorite at the expense of hornblende, we find a mica-chlorite schist formed. See [8311, 8364, 8366, 8567.]

The following are detailed descriptions of some typical sections of these granitic rocks:—

[8151] Sec. 880. Soda-granite, Western Well on W.R. 7517. Coarse grain. Quartz and felspar about equally abundant. Quartz with numerous inclusions mostly "dusty" but some fine spicular, the former under high powers are seen to include minerals and liquids with gas bubbles. Large prisms of apatite are seen in some of the quartz masses. Felspar mostly multiply twinned and much clouded with granular grey matter. Brown biotite is the chief ferro-magnesian mineral, much green hornblende being associated with it. A little ilmenite is present in fine and coarse grains partly altered to leucoxene, also a little pyrites in patches. The ferro-magnesian minerals evidently preceded the felspars in crystallisation, quartz being the last constituent to settle out.

[8139] Sec. 877. Soda-granite, W.R. 4. This is a somewhat darker rock than [8151] and has a coarse texture. White felspar is altogether absent, to the greenish albite no doubt being due the deeper colour of the whole. Although the analysis given above has shown the rock to have a higher percentage of SiO_2 than [8151], the quartz only takes the second place in the micro-section examined, it has a very similar appearance to that in the section just described, except that the stringy arrangement of the enclosures is perhaps more marked. The felspar is cloudy and in this case contains needles and rods of apatite and fragments of hornblende, it shows some fine examples of the usual repeated twinning on the Albite plan. The strongly pleochroic hornblende needs no remarks except that it is very full of enclosures and has a very ragged outline. Ilmenite is present in fair abundance. Order of crystallisation evidently the same as in [8151].

[8147] Sec. 876. Soda-granite, near W.R. 7607. A coarse-grained rock similar to the preceding but much darker owing to the large development of hornblende. This is the most prominent constituent; there is a fair amount of felspar and some quartz. Under the microscope felspar and hornblende are seen to form the main mass of the rock, the former is idiomorphic as regards the quartz, cloudy owing to alteration and mainly composed of the plagioclase variety. The hornblende is very brilliant, generally

green or yellow according to the section's direction; at times it is brown owing to iron staining and in many cases gives splendid examples of twinning parallel to the orthopinacoid. The quartz is well represented and in some instances, besides the usual style of enclosures noted in the other sections, mica (biotite), ilmenite (leucoxene), and zircon are present, also fine needles of rutile or tourmaline similar to those noted in [8151].

[1875] Sec. 106. Soda-granite, three miles west of Mt. Desmond. This is slightly different in appearance to any previously described. It is coarse grained with much white felspar and some clear quartz, in which are imbedded numerous well defined long and somewhat narrow crystals of hornblende. Under the microscope the allotriomorphic character of the quartz is very evident. Crystals of apatite are not seen, but on the other hand many fine, long, slender needles of a dark brown mineral (tourmaline or rutile?) are found besides the usual small enclosures of minerals, liquids, and gases. Plagioclase is the chief felspar and often shows repeated twinning and large patches of decomposition products. Deep brilliant green hornblende is very abundant being represented by large well defined crystals, frequently twinned, and enclosing somewhat numerous grains of iron ore and rods of rutile, generally arranged along the cleavage lines. A little pale secondary hornblende is present as also a little biotite in places.

[8152] Sec. 881. Soda-granite, near W.R. 8358. A somewhat finer grained rock than any of the previous ones, in which pale grey felspar is the most prominent constituent. Small crystals of hornblende are very uniformly distributed. Under the microscope the chief constituent is seen to be felspar, much clouded and, for the most part, devoid of twinning. It contains numerous enclosures of apatite. The quartz which is about equally abundant contains dusty and fine spicular enclosures. Green and brown biotite is common, sometimes intergrown with muscovite. Dark green hornblende is abundant in coarse crystals, with a little ilmenite. Occasional crystals of zircon are seen.

[8318] Sec. 904. Soda-granite, W. R. 7385. A fine grained grey rock. Much clouded felspar, devoid of twinning, forms the greater part of the rock. Quartz and hornblende both abundant. The quartz contains numerous enclosures, apatite, rutile (tourmaline?), hornblende and zircon are recognisable. Also liquid and gas inclusions, the cavities sometimes taking the form of negative crystals. Some ilmenite partly altered to leucoxene.

[8310] Sec. 900. Altered Soda-granite, M.L. 236, Oversight Extended. A fine grained massive rock. Under the microscope cloudy patches of felspar are still visible, though boundaries are very ill defined and the usual interference effects barely distinguishable. Finely granular quartz, hornblende, biotite, ilmenite and epidote make up the balance of the rock which is inclined to be slightly gneissic in structure.

[8553] Sec. 935. Quartz Ceratophyre, 400ft. level, Mt. Cattlin C.M. Dark grey, very fine grained, massive rock, with visible phenocrysts of quartz and felspar. Specific gravity of 2.68. Contains silica, 71.01 per cent.; potash, 0.55 per cent.; soda, 5.36 per cent. Under the microscope the rock is seen to consist of a fine grained crystalline ground mass of felspar (albite), biotite and quartz, in which are embedded numerous phenocrysts of cloudy felspar, mostly if not wholly plagioclase. Brown biotite occurs somewhat freely in phenocrysts. A greenish chlorite, some epidote and a few crystals of zircon are seen. Though quartz phenocrysts are not uncommon on the faces of hand specimens, none were included in the section examined.

[8463] Sec. 914. Andalusite Rock. Sunset Mine. This is a greyish sericitic rock showing many fine large crystals of flesh-coloured or pink andalusite. By the aid of the microscope we see that it is essentially composed of a sericitic ground mass containing fine porphyritic crystals of andalusite and some smaller ones of phlogopite or some allied mica. Many small masses of secondary quartz as well as small crystals of rutile and ilmenite and other unimportant assessories are easily to be distinguished.

[8143] Secs. 873 A to F. Andalusite Rock and Schist (Hornstone). Near M.H.L. 126, Ravensthorpe. This specimen is of exceptional interest in that it consists of an andalusite rock, similar to the above, a portion of which has been so crushed and squeezed that not only a schistose but also an "augen" structure has been superinduced. Six sections heve been made of this rock, both in the crushed and the uncrushed portions. In the latter as in [8463] we see numerous large and small phenocrysts of andalusite full of various enclosures, amongst which were recognised tourmaline magnetite and long slender needles that may be tourmaline but which are too slender to be determined with certainty. Smaller crystals of felspar, tourmaline and biotite are also present in a ground mass composed essentially of sericitic or chloritic material.

The crushed and altered portion shows the same constituents, which have been so much affected that they have assumed a flow structure, the large crystals, even the hard andalusite, being crushed and squeezed out of shape in a most remarkable manner.

[8311] Sec. 901. Mica-chlorite Schist. Near shaft of M.L. 236, Oversight Extended.

This is a greyish green rock having a schistose structure and a somewhat silvery sheen due to the small flakes of chloritic and sericitic material present. The microscope shows that the rock is an altered acid rock. We have a fair amount of quartz showing "strain figures" in a matrix composed of sericitic, felsphatic and chloritic material, the latter being most plentiful in those places where small crystals of rutile and iron ore indicate the former presence of ferro-magnesian minerals.

[8567] Sec. 969. Mica-chlorite Schist. Mount Desmond Mine. The general appearance of this rock is similar to the above in every way. Microscopical examination shows that here again the main mass of the rock consists of chloritic and sericitic material in small scaly masses, in this are many irregular pieces of quartz which on further examination are seen to consist of numerous fragments, the general appearance of which suggests a secondary origin. In places the rock is quite green owing to the great abundance of chlorite, and here again we find an abundance of rutile crystals (prisms, etc.) as evidence of the former presence of a ferro-magnesian mineral. Several hexagonal crystals of zircon are to be seen, being the prism with its two pyramids. Iron ores are also present, particularly in those portions of the field where the rutile crystals are most abundant.

ROCKS OF INTERMEDIATE BASICITY.

Large areas of "greenstones" of intermediate basicity, partly massive and partly schistose, are shown on the map, and associated in part with them several more or less distinct types of dykes, including (*a.*) Quartz diorites of two types, (*b.*) Diorites characterised by a very large preponderance of primary hornblende, (*c.*) Diabases in which the chief ferro-magnesian mineral is fresh or altered augite, (*d.*) Lamprophyres (Kersantites) in which the chief basic mineral is biotite.

Amphibolite.—One mile nor-nor-west of Mt. Desmond, close to the limits of the map, is a rock [8322], which appears to the eye to be composed wholly of very large crystals, of a somewhat light green amphibole. It is distinct in appearance from any rock within the area mapped, except perhaps [8468], and resembles some of the amphibolites of Kalgoorlie and elsewhere on the goldfields. Like them, it appears to be an altered pyroxene rock. (*See* "Serpentines."

Massive Diorite Rocks and Camptonites.—From the main mass of greenstone in the Northern part of the field come two types of rock—1st, a dark green massive rock, somewhat coarse-grained and seen under the microscope to consist almost entirely of deep green, well-crystallised hornblende, with a little interstital quartz and clear felspar [8465, 8469]. 2nd, a light to dark green rock, which, under the microscope, is seen to be fine grained, with a fine granular base of felspar, iron ore and usually quartz in which are embedded numerous small, and some large crystals of green or colourless hornblende [7826, 8145, 8388, 8464]. The structure of these dykes differs considerably from that of typical diorites, and partly because of their structure, partly because of their affinities with the kersantites, they are provisionally classed as camptonites. Biotite occurs in both types in variable amount.

Diorite Dyke Rocks with much Hornblende.—A number of dykes are composed of a rock which is almost wholly hornblende, the colouring of which is very distinctive, viz., rich blue green,

strong green and pale yellow [8140, 8141]. The interstital matter is mainly felspar and the rocks are either coarse or fine grained.

Quartz Diorite Dykes.—These differ somewhat amongst themselves, both in texture and composition, some being barely distinguishable from the previous mentioned rocks except for the quartz, the hornblende being very plentiful and of the same type as in the last group. Other specimens exhibit much quartz, whilst the hornblende is subordinate to the plagioclase. The hornblende in some tends to gather round nuclei, forming bunches 5 or 6 m.m. in diameter, and distant about 10 m.m. apart, and in these rocks chalcedony is somewhat freely developed [8149, 8317, 8327, 8359].

Enstatite Diabase.—A single example occurs of a very fresh coarse grained rock [8144] composed of clear multiply twinned felspar and augite, with subordinate hornblende, enstatite, ilmenite and quartz. A fine grained weathered rock [6052], consists largely of serpentine, with a structure which would suggest a pyroxene as the original mineral from which it is derived.

Kersantite.—In the Elverdton mine and its immediate vicinity, there is a fine grained dark coloured dyke rock, composed of a granular mixture of clear felspar and biotite, with a little hornblende and quartz [8462, 7822, 7912]. The silica percentage in a typical example [8462] was found to be 59 and the specific gravity 2.81.

Biotite Schist.—Biotite appears to develop readily at the expense of hornblende in all these rocks of intermediate basicity, giving rise ultimately to biotite schists [1895, 1907]. Examples occur at Ravensthorpe, Mt. Desmond and Kundip, and show all the features characteristic of pressure metamorphism.

Garnetiferous Schist and Eclogite.—A number of examples of greenstone schist are characterised by the occurrence of a garnet which, where determined, has proved to be grossularite. One such rock [8155], the chief constituents of which were green hornblende and plagioclase with subordinate iron ore, garnet, and quartz, has the following composition:—

SiO_2	62.23
TiO_2	1.51
CO_2	.23
P_2O_5	.28
H_2O combined	.34
K_2O	.29
Na_2O	1.47
CaO	6.16
MgO	4.09
MnO	.56
FeO	10.46
Fe_2O_3	.08
Al_2O_3	11.90
FeS_2	.79
H_2O hygroscopic	.07
	100.45
Sp. Gr.	2.96

Biotite is very freely developed in some of these rocks at the expense of the hornblende [1906, 8533], the schistosity of the rock being usually in direct ratio to the proportion of biotite present. The hornblende varies from almost colourless to dark green. The proportion of garnet present is very variable, but in all cases it appears to be a late development, as it encloses numerous fragments of the other minerals.

Chlorite Schist.—This does not appear to be a common rock on the field, but examples of it are present in the collection [8311, 8366]. They are evidently altered hornblende rocks.

The following are detailed descriptions of such of these rocks as have been examined in detail:—

[8322] Sec. 948. Amphibolite, one mile N.N.E. of Mt. Desmond. This is a greyish green rock showing large lath-shaped crystals of hornblende of irregular outline, some of them being as much as 30 m.m. in length. The whole rock has an altered appearance and suggests the presence of a good deal of chloritic material. The microscopical examination shows that the alterations typical of pyroxene rocks are very far advanced. We get no felspar, but just a mass of aluminous hornblende, altering pyroxene and chloritic or serpentinous material. Needles of tremolite are very common in the amphibole masses. (See Serpentines [8154, 8326]).

[8144] Enstatite Diabase, W.R. 7517, and

[8568] Enstatite Diabase, Mt. Desmond Mine. Though these two dyke rocks were obtained some distance apart they resemble one another very closely though [8144] seems somewhat fresher. The hand specimens show a medium grained dark blue or dark green rock with many bright faces of augite crystals, the whole being mottled through the presence of whitish masses and lath-shaped crystals of plagioclase. Traces of pyrites are also to be seen. Under the microscope the chief constituent is seen to be pyroxene. We have it in two habits, in some places an "ophitic" structure is developed whilst in other the augite takes the form of small granules. The mineral shows good examples of twinning, and often exhibits the characteristic cleavages of the group. Further examination shows that there is a rhombic-pyroxene as well as the monoclinic augite, and this, on account of its straight extinction, its almost total lack of colour and very weak pleochroism as well as its highly developed cleavage has been classed as Enstatite.

In [8144] some fine masses or crystals of this mineral are to be seen, one piece in particular being interesting, as it shows the decomposition gradually encroaching upon the whole mass: near the centre the mineral is still very fresh, but as the edge is approached chloritic material is seen to fill the cracks or cleavage lines, coming more and more in evidence, till at the extremity all the pyroxene has disappeared and we have simply a mass of

greenish and brownish chlorite adopting a rudely spherulitic structure, portion of which might be taken for serpentine.

Though twins of enstatite are rare, one was seen in [8568], in which the twinning was along one of the cleavage planes.

In [6052], from the Last Chance Mine, the enstatite and augite are more difficult to separate on account of the small size of the crystals, for in this rock as well as [8568] the ophitic structure has disappeared, and the whole of the pyroxenes are granular.

In thin sections the augite has very little colour and gives practically no pleochroic colours, but with the crossed nicols bright colour effects are obtained as well as unmistakable evidence of twinning.

Taken on the whole the mineral is very fresh, those alterations that have taken place being confined to certain portions of the slide. At the same time good instances can be seen, especially in the more coarse-grained examples, of the mineral altering into chloritic material; it being in some cases completely converted into spherulitic aggregates of chlorite which send out tongues into the surrounding felspar by means of the cracks and cleavage lines. In other examples every step in the transition from pyroxene to hornblende and biotite can be traced, the alteration even extending beyond this into a green chloritic material similar to that just referred to. Another alteration product of the ferro-magnesian minerals and the felspar may be noted here, it is Epidote which is to be seen in [8568] and [6052] usually taking the form of irregular yellowish grains showing slight pleochroism and bright colours with the aid of crossed nicols.

The plagioclase felspar of the rocks is very conspicuous, forming fine idiomorphic lath-shaped crystals which give fine examples of twinning on the Albite plan. The mineral is very fresh and clear, only occasionally showing signs of saussuritisation. Upon measuring the extinction angles of the twins it is found that in almost every case the mineral was well within the labradorite margin, 30 degrees or over. Quartz is also present as an original constituent as is shown by its micro-pegmatitic intergrowth with felspar in several of the slides examined [8144]and [8568]. Interstitial masses and grains are also present, and show by their outline that they were formed late on in the course of crystallisation. some of the masses may even be secondary, but that does not seem likely in this group of the Phillips River rocks. Apatite is a common inclusion. Titaniferous iron ore is also to be seen as an original constituent; some of the crystals, being in close conjunction with altered or altering ferro-magnesian minerals, are without doubt of secondary origin. The undoubted secondary minerals, chlorite, biotite, hornblende, epidote and serpentinous matter, have already been mentioned in passing. The most important one is hornblende; from its associations with the augite there is no doubt that this is purely secondary, for all the steps can be seen between

the unaltered augite to the fresh green hornblende with its clear colours, its fine cleavages, and in many cases its almost perfect outline.

Biotite both green and brown in colour is often associated with the hornblende as an alteration product, it is very fresh and shows few signs of decomposition, except for the presence of chloritic matter at the fibrous extremities of some of the masses.

[8140] Altered Diabase, near M.H.L. 16. This is a dark blue or blue black dyke rock showing many bright cleavage surfaces of hornblende. With the microscope it is seen that the rock is practically a mass of ferro-magnesian minerals and their alteration products, we see hornblende in large masses showing many twinned individuals giving fine examples of prismatic and basal cleavages, good pleochroism and very bright polarisation colours:—

a = Straw yellow.
b = Yellowish green.
c = Blue green.

Its structure and form suggest that it is of secondary origin Some of the masses are altering and passing into green chloritic material. Enstatite is present. Plagioclase felspar is represented by a few odd lath-shaped crystals. A little epidote seen, a grain or two at the most.

This rock is evidently very poor in felspar, and is either derived from a similar diabase or the felspar has disappeared entirely, being replaced by aluminous hornblende and chlorite.

[8328] Altered Diabase, near M.H.L. 67. In this the stages of alteration are further advanced, although some felspar (?) is present. It is a grey rock with yellowish patches and appears to consist entirely of hornblende, augite, and decomposition products (bastite, etc.).

Under the microscope we see that the main mass of the rock consists of chloritic and serpentinous material, imbedded in which are the remnants of many of the original minerals, the enstatite is converted into bastite, and the augite is present in very much more corroded masses than in [8322]. Felspar is represented by ill-defined and much clouded masses and patches, generally limited in extent and too impure to allow a determination of the group to be made. Iron ores are present in the form of grains and crystals, the former often filling veins penetrating the mass. In some parts, too, the ferruginous material has stained the adjacent minerals and alteration products.

Secondary hornblende giving bright polarisation colours and showing characteristic cleavage is not rare, generally it is very pale-coloured and fibrous, the needles often resembling tremolite. The rock is a serpentinous rock with bastite, and is clearly an altered form of an enstatite diabase.

[8317] Sec. 903. Quartz diorite with chalcedony, W.R. 7385. This is typical of this well-defined type of dyke rock which in-

cludes also [8149, 8327, 8359]. Plagioclase felspar is the chief constituent, its habit is usually lath-shaped crystals of rectangular outline, and in this group of rocks it is evident that in the majority of instances it is idiomorphic. On the other hand fields are seen in all the sections examined that give good examples of micro-pegmatitic intergrowths with quartz. As regards its structure, the felspar is very much altered, being almost entirely converted into saussurite from the centre outwards to the edges of the crystals. Sufficient evidence was, however, on hand to determine the presence of repeated twinning on the albite plan in the original unaltered mineral, this was seen to the best advantage in [8149, 8317]. Owing to the state of alteration of all the crystals it is impossible to say whether the mineral contained enclosures in its original state, the masses as now seen give no evidence of this. In some sections part of the slides show the presence of hornblende fibres and chloritic matter in the forms of granules and fibres as an alteration product of the rock. The quartz of this group is present in the usual irregular masses so much associated with the granites, and, as already mentioned, in micropegmatitic intergrowth with plagioclase felspar. The mineral, when compared with samples from other rocks, is very free from inclusions. When these are present they generally take the form of long narrow needles which show up in high relief (rutile or tourmaline), or are present as prisms and hexagons of apatite. Zircon was also seen in a similar rock [8149]. Silica is also present in a cryptocrystalline condition, and is a very distinctive feature of this group. Every slide gives good examples of radiating tufts and spherular aggregates of chalcedony usually associated with the quartz and in [8149] seemingly a decomposition product of the felspar.

The identity of the original ferro-magnesian mineral is a matter of some doubt, owing to the amount of alteration that has gone on since the rock was formed. An examination of all the sections shows that whereas its relationship to the felspar is distinctly allotriomorphic it is difficult to say how it stands with reference to the quartz on account of alterations that have taken place.

Some of the sections suggest augite in the long lath-shaped crystals so often associated with trachytes, and this is most likely the original mineral of this group. Whatever the primary mineral was, it has now quite disappeared, and in its place we usually get a greenish yellow or greenish hornblende with the characteristic habit and cleavages of the mineral, greenish chlorite and chloritic material and biotite.

The outward appearance of this rock suggests much altered hornblende, and the microscopic section proves its truth. Here we see practically none of the original mineral, its place being entirely taken up by secondary hornblende, altering hornblende, chloritic material and chlorite. This latter product can here be studied to

great advantage, every step of the change can be viewed, and it is seen to be much more complete than was shown in any of the other sections, the coating of the felspar crystals, the penetration of the chlorite and the alteration of the adjacent felspar into epidote is most apparent. Ilmenite and leucoxene are abundantly associated with the hornblende, etc., in this section.

[8149] Sec. 879. This is a medium-grained greyish rock consisting of felspar, quartz, and hornblende, with numerous segregations of the latter mineral, 5 or 6 m.m. in diameter and rarely more than 10 m.m. apart. The chief constituent is seen to be plagioclase, showing a tendency to form lath-shaped crystals and giving some examples of repeated twinning. Quartz is very plentiful and appears to have been the last mineral to crystallise out, it is clear, contains few inclusions, chiefly minerals (? apatite, etc.). Hornblende is scattered throughout the section, it is rather altered and iron-stained, has a greenish yellow hue, and is darker near the edge. There is a good deal of titaniferous iron present in the rock. Zircon, apatite, epidote, and chalcedony present as secondary minerals. A little fresh, clear, and bright secondary hornblende is to be seen at the edge of some weathered masses of the same mineral.

[8327] Sec. 907. Quartz Diorite near Elverdton Dam. This is a mottled rock of medium grain composed of masses of dark green or blue hornblende and white or greenish plagioclase. Under the microscope the rock is seen to consist of plagioclase, hornblende, and quartz with ilmenite (leucoxene) and apatite. As alteration products or secondary minerals may be mentioned epidote, chalcedony, secondary hornblende and chlorite. Plagioclase is present as the chief constituent, and it is very cloudy, so that it does not give good polarisation reactions, still its outline is very distinct, and suggests this mineral rather than orthoclase. It often contains small inclusions of the ferro-magnesian minerals present in the rock. Hornblende is present in two ages, the one brownish in colour and much iron-stained is idiomorphic and is fairly plentiful. In places it is changing into a bright green and fresh-looking hornblende, the nature of which can easily be determined on examining crystals placed adjacent to quartz and felspar. Quartz is very nearly as plentiful as the original hornblende. It contains numerous inclusions consisting of apatite, etc. Associated with it are many masses of chalcedony. A fair amount of ilmenite, changing into leucoxene, also epidote, chlorite, apatite, and zircon are present.

[8359] Sec. 910. Quartz Diorite. 25 chains N.W. of N.W. corner of G.M.L. 101, Ard Patrick. This is a medium-grained granitic rock, the chief constituents being white plagioclase felspar, at times inclined to be greenish in hue, and dark green hornblende which is generally in lath-shaped crystals. A little quartz could also be recognised by the aid of a lens.

Under the microscope cloudy twinned and untwinned felspar is seen to be the predominating constituent; its usual tendency is to crystallise out in long rectangular crystals, but in some portions of the slide a fine micro-pegmatitic intergrowth with quartz is seen, in others there is not the slightest doubt that the felspar is idiomorphic as regards the hornblende. The mineral is very cloudy and contains many inclusions of hornblende and chlorite.

The hornblende is present in two ages, the original mineral is brownish in colour and only slightly pleochroic, whilst its effect upon light with crossed nichols is not very marked. The secondary mineral, however, is a bright green, and gives bright colours and shows intenser pleochroism.

The older mineral is much altered, and is associated with a number of fine ilmenite crystals, and may have been formed before the felspar. The quartz is present in fairly large crystals and interstitially. On the whole it is very clear and free from inclusions, though a fair number of apatite rods are to be seen. Its micro-pegmatitic intergrowth with felspar has already been noted. A little brown biotite is seen and some chalcedony may be present.

This will be a quartz diorite rather more basic than [8149, 8317, 8327]. Chalcedony appears to be present; a little was seen but it was so limited in extent that it could not be seen to advantage.

[8316] Sec. 923. Quartz diorite. Near S.W. corner of G.M.L. 132, Darley. This is a medium-grained rock of a granitic type, it differs from all the other specimens from the district in the presence of pink felspar, the other components are hornblende and plagioclase, the ferro-magnesian mineral being slightly porphyritic.

Under the microscope the porphyritic structure is accentuated and it is seen that plagioclase is present in lath-shaped crystals and in smaller masses, being in fact the chief constituent. The rock is fairly fresh, and in consequence we get good polarisation results when compared with the other quartz diorites. In places micro-pegmatitic intergrowth with quartz is to be seen. Twins very common, giving an angle of 15 degrees (oligoclase-andesine).

The quartz is fairly abundant in small sized grains, and in larger masses, where it is associated with the felspar, it resembles the quartz of the other classes of rocks examined, in the presence of needles of rutile (or tourmaline) and prisms of apatite as inclusions, besides more minute crystalline matter that could not be identified. The ferro-magnesian constituent presents interesting features. The original mineral has become greatly changed; in places it is still present as a green hornblende, but as a rule it has become disintegrated, has altered into epidote and secondary hornblende, which is very fresh, and shows the characteristic cleavages, or has given rise to greenish chloritic material which

has spread into the adjacent minerals. The relationship between the felspar and the hornblende was difficult to ascertain on account of the alteration subsequent to crystallisation, but it is safe to assume that here again the felspar is idiomorphic, whereas the quartz is interstitial where not intergrown with the felspar. Ilmenite and leucoxene are present as accessories, and show their usual features, including skeleton crystals. Apatite is present in some fine large prisms. Biotite is to be seen in the masses of alteration products resulting from the decomposition of the original ferromagnesian mass. There seems no doubt that some of the iron ores are the result of the same process of alteration.

[8148] Sec. 878. Quartz diorite, near M.L. 248, Red Hill. This is a medium-grained rock with white crystals of felspar and dark green hornblende in one part, whilst in the other portion the texture is finer and there are no large crystals. On one side of the specimen a layer or band of biotite covers nearly the whole surface, showing that the rock has been subject to a considerable amount of metamorphic action. The micro. section examined shows both the fine and coarse-grained rock. In the latter portion we find that altering plagioclase and secondary felspar (albite) are the chief constituents; the former is so much altered that the polarisation effects are quite obscured, and no determination is possible. The albite on the other hand is quite clear and fresh, and gives good opportunities of measuring the extinction angle—16 degrees.

The hornblende is very fibrous in its structure, but gives fine polarisation colours and quite distinct pleochroism. There is a good deal of iron ore present in the form of ilmenite, which by its relationship with the hornblende suggests very forcibly that both these minerals are the resultants of metamorphic action upon the original ferro-magnesian mineral, which contained much more iron than the present fibrous hornblende. Apatite is present as an original, whilst chlorite and biotite (enclosing lenses of quartz) and quartz are present as secondary minerals, though some of the last-named may be original.

In the more fine-grained portions we have the same minerals, but here they are all uniform in size, and we have a greater amount of secondary quartz and albite. The brown bleaching biotite is also much more abundant, the whole fine-grained mass reminding one very much of the Kersantites, though the colour of the biotite is not identical. In this rock the form of the hornblende is the most noticeable feature, for this variety is only rarely met with among the other rocks examined. We generally get a weathered or altering hornblende giving somewhat anomolous colours and a fresh secondary form in which—

$\mathfrak{a}$ = straw yellow.
$\mathfrak{b}$ = dark green.
$\mathfrak{c}$ = blue green.

These colours do not agree with those given by the fibrous form

present in [8148], which reads very pale straw, green and pale blue.

Among this group of quartz diorite rocks there are several specimens which are much finer in structure; these are [8141, 8313, etc.], which will now be described, the latter shows white or pale patches which look like somewhat altered or weathered felspar, as [8141]. This, which we take to be the better sample, will be gone into first.

It is a blue-black compact rock showing nothing but hornblende crystals to the naked eye. By the aid of the microscope it is seen to consist of green or greenish hornblende usually in the form of fibrous masses somewhat similar to [8148], but not differing so much from the usual run of hornblende met with in the diorites. Under the microscope the general type of the rock is very like the diorites just described, the felspar (plagioclase) is present in idiomorphic crystals all much altered and in irregular masses. Some of them show signs of twinning and give polarisation colours, but not of sufficient value to enable the group of the felspars to be diagnosed. Albite, however, is present. The hornblende is very similar to that described before, and from its freshness is probably secondary. Very little quartz is present, and that which is to be seen is interstitial and secondary. No accessory minerals are recognisable in this rock. Among the chief constituents the hornblende is by far the most important, and is remarkable for the presence of small needles which are forcing their way into the felspar on every hand.

[8313] has already been described as regards the hand specimen. The micro slide shows the rock to be more altered than the preceding. The hornblende is very fresh and gives some splendid examples of basal and prismatic cleavages and twins, whilst all the masses give good pleochroism and polarisation colours. The felspar, which is taken to have been a plagioclase, is much altered, some masses being completely altered into saussurite, not a single mass being fresh enough to allow the determination as to group to be undertaken with success. The quartz is clear and contains fine prisms of apatite, but few other inclusions. Suggestions of micro-pegmatitic intergrowth with felspar are to be seen here and there. Ilmenite is present as skeleton crystals, and is evidently in part, if not wholly, an alteration product derived from the original ferro-magnesian mineral. Sphene and biotite are also to be seen as well as a little epidote.

[8565] This fine-grained rock is somewhat darker in colour, but its essential points agree with the two previous rocks. With the microscope we see that it consists of much altered felspar (saussurite) and green hornblende and chloritic material. The hornblende is much changed, and only in rare intervals gives good or fairly good polarisation results. Most of the ferro-magnesian mineral has undergone a great deal of change, and has even gone

as far as to be partially converted into chlorite. Secondary albite and quartz are abundant, filling up all the cavities between the larger masses of minerals. Here we evidently have to deal with a diorite that is very highly altered, indeed, perhaps more so than any other of the series; a rock, too, which may be found to be a connecting link between this group and the so-called "Camptonites" which are to be described later on.

[8465, etc.] Camptonites. These rocks are all fine grained, and of a grey-blue or grey-green colour. As a rule they show no definite crystals, though traces of cleavage faces and crystal faces can easily be seen even with the naked eye. The constituents are chiefly hornblende, which is present in large crystals of a secondary nature [7826, etc.] or in smaller crystals and grains [7825, 8465] that at times can scarcely be termed porphyritic. The felspar is sometimes represented by weathered porphyritic original crystals, but generally is only seen as one of the component parts of an albite quartz matrix or mosaic. Accessory minerals in the form of iron ores, etc., are to be seen. As the structure of some of these differs from the true camptonite type it has been thought necessary to draw attention to the fact before proceeding further.

The rocks themselves too show a diversity of structure generally however of a purely secondary nature. Roughly speaking, they may be divided into two or three classes. We have the series [8465, etc.], which show the following micro structure:—

The hornblende is very abundant, consisting of green and yellowish masses and lath-shaped crystals scattered promiscuously throughout the mass and adopting a rudely aggregated structure. Its general appearance is very characteristic, these remarks refer not only to its shape or form but also to its pleochroism and polarisation effects. The felspar as already mentioned is practically confined to the ground mass where it and quartz form a very fine grained mosaic so characteristic of secondary albite. Some of the sections, particularly [7825], show the remains of large twinning porphyritic crystals of plagioclase, which are much altered and full of needles and prisms of green hornblende. Brown biotite and epidote are also to be seen as secondary minerals.

In most of these sections we find small grains of iron ores (ilmenite, etc.), scattered all over the field. These it seems are the result of the alteration of the original ferro-magnesian mineral altering into a less iron-bearing form.

[8319] is a very similar rock to all the above, but shows signs of incipient schistosity in the parallel arrangement of the smaller hornblende prisms.

[8325] is a rock very similar to this group of Camptonites. We have the albite mosaic and grains of iron ores and the usual hornblende, this latter however seems to be altering into long, clear, colourless prisms or needles that may be an amphibole, but which are difficult to determine with certainty; the whole rock is very cloudy and is evidently altered and weathered.

The second class of Camptonites differs from the first in the presence of many long, clear hornblende crystals which seem to be forming out of and on the smaller masses of the earlier generation.

[7826] shows the albite mosaic and the grains of iron ore in their characteristic forms as noted in the earlier Camptonites. The hornblende, however, is different, the earlier generation is present in small fragments of a brownish hue, but are almost pushed out of existence by the many masses of the later amphibole. This is seen in long ragged masses and well defined crystals giving good cleavage lines and very characteristic pleochroism and polarisation results. Many fine twins are to be seen. Quartz is present in conjunction with the albite, copper pyrites fairly abundant, apatite seen. Biotite may also be present but is not easy to determine in this specimen.

[8145] is very similar to the preceding, the biotite is easily recognised whilst the remains of porphyritic felspar crystals are very prominent. A little apatite is also noticeable in long, slender rods.

The next three rocks, though they resemble the preceding to a great extent, have some features in common with the Kersantites, for instance, brown hornblende and biotite are becoming more prominent, so much so in fact that it is a matter of doubt whether they might not just as well be classed as Kersantites, which practically only differ from Camptonites in a greater percentage of biotite and a smaller amount of hornblende.

In this district, at any rate, the main features of the two groups and their constituent minerals only vary in their relative abundance in the main masses of the rocks. The biotite is not produced by pressure for no signs of schistosity can be seen on any of the specimens.

[8560] contains the remains of phenocrysts of plagioclase now converted into albite, a much greater abundance of hornblende and a good deal of ilmenite, giving some fine skeleton crystals. As before stated, all the minerals are very clear and look exceedingly fresh.

[8561] similar to the above, but with rather finer grained hornblende, more brown hornblende and biotite and altering felspar forming albite and quartz and sericite (?).

[8469] is practically an amphibole rock with a little interstitial albite quartz and iron ore. Even in the hand specimen the mass is bristling with crystals of hornblende showing their bright and glistening cleavage faces.

The "Camptonites" appear to pass by insensible degrees into typical Kersantite dykes, members of the former group being known with less hornblende and considerable biotite and of the latter group with much hornblende in addition to much biotite.

[7912] Sec. 947, Kersantite. 300 feet Mt. Cattlin Mine. This rock bears a great resemblance to [8469] the only noticeable difference being a greater proportion of felspar apparent to the eye; the presence of more veins and the presence in them of quartz and felspar.

Under the microscope it is seen at once that we are dealing with a different type of rock, whereas bluish green, green, yellowish green hornblendes are still the chief constituents as in [8469], the percentage of biotite has risen considerably. This ferro-magnesian mineral bears the same relationship to the hornblende as in the other rock, similar phenomena being noticed. Again there is a greater amount of weathered felspar and interstitial albite, together with the occurrence of rather more quartz and mica. From these facts it would not be indefensible to class this rock as a type intermediate between Camptonites and Kersantites.

The specimen examined is not very fresh, the hornblende has lost some of its clearness, the felspar (excepting the secondary albite) is very cloudy and the mica shows lenticular enclosures which in some cases are possibly calcite and in others (giving lower polarisation colours) are undoubtedly quartz. This biotite also shows signs of altering into a green decomposition product.

[8557] is very similar to the above, the minerals are smaller. The quartz is more equally distributed throughout the rock and augite is represented by a few small grains.

[7823] shows all the essential features of the above. Chloritic decomposition products are associated with the biotite and octahedra of magnetite make their appearance. Two porphyritic crystals of quartz are to be seen in the section round which the other constituents (chiefly the biotite) have formed themselves in a manner which suggest "flow structure" or "augen structure."

[8466] shows a general structure similar to the preceding but differs in the greater abundance of small laths of green hornblende and numerous octahedra of magnetite.

[8467] from a neighbouring mine shows much more olive brown biotite and less hornblende and has no quartz phenocrysts.

[7822] is like the preceding but contains two altering plagioclase crystals which are porphyritic.

[8462] is similar to the above showing a few quartz phenocrysts as well as the plagioclase.

[8468]. In this we have a rock very like some of the Camptonites as well as the Kersantites. In a ground mass consisting of a mosaic of albite, green prisms, rods, or laths of hornblende, etc., we have large porphyritic crystals of corroded biotite being altered into long fibrous crystals of a clear and colourless hornblende which gives fine colours and in places shows the characteristic cleavage. To increase the resemblance a fair amount of ilmenite and pyrites is scattered throughout the rock.

This will be an intermediate type which bears a greater resemblance to Kersantites just as [8560, 8561, 8469] swing towards the Camptonites.

[8155] Sec. 883, Hornblende-Eclogite. Ravensthorpe Range, east of Ravensthorpe. An analysis of this rock is given on page 27.

Microscopical examination shows a fair number of small pale pink garnets full of inclusions of the matrix, in a schistose mass of fine grained quartz, albite, hornblende, the latter often showing a tendency to form radiating tufts. A few larger phenocrysts of primary quartz and very cloudy lath shaped felspars are present. Ilmenite is abundant, a few grains of epidote, bright yellow in colour, are also to be seen. This is an altered rock of intermediate composition.

[1911]. This is very similar to the above, but contains numerous garnets and is rather darker in colour. The micro-section shows many pale clear garnets and a few large crystals of quartz and felspar in a matrix of quartz, albite and hornblende, the latter as in [8155] being very abundant. This is most likely a portion of the same rock altered in a similar way.

[1883] is similar to the preceding but paler in colour. Microscopical examination shows fine clear pink garnets full of enclosures and pale fibrous hornblende in a matrix of quartz albite and hornblende with countless grains of ilmenite bearing a great resemblance to some of the so-called "Camptonites."

[8533] is micaceous and schistose and is best termed a Garnetiferous biotite schist, the garnets are very numerous and of large size.

[1906] is very similar but has much smaller and fewer garnets.

ULTRABASIC ROCKS.

Serpentine.—The most basic class of igneous rocks is represented by an intrusion now all converted into Serpentine. On the surface this weathers largely into magnesite.

[8154] Sec. 882, Serpentine, ½ mile W.N.W. of the Last Chance mine. This is a mottled dark blue and greenish rock consisting of patches of green material in a dark blue base. Traces of a crystalline structure can be seen particularly at one edge of the specimen. The whole rock has a serpentinous appearance. Under the microscope the rock shows much green serpentine, as well as the remains of felspar crystals. From the structure of the former and the distribution of the magnetite it seems probable that the original rock was an olivine gabbro.

[8326] Sec. 924. Serpentine, 2 miles S. of M.L. 266. A blue black rock with yellowish-green patches. Under the microscope the rock is seen to be an almost pure serpentine with mesh structure and minutely fibrous. A fair amount of magnetite dust is present as well as some quartz grains. Evidently an altered peridotite.

See also "Amphibolite" [8322].

Rd. No.	Collector.	F. No.	Section.	Name.	Locality.
				Acid Rocks.	
1875	T B	..	106	Soda Granite	Three miles W. of Mt. Desmond
1898	T B	..	964	Do.	Jim Dunn Wonder, Ravensthorpe
7911	..	..	..	Do.	Bore Core
8139	H W B T	1	877	Do.	Well, 25 chains S. of No. 2 Tank, Ravensthorpe
8142	H W B T	4	872	Do.	10 chains S.E. from S.E. peg of Recreation Reserve, Ravensthorpe
8147	H W B T	9	876	Do.	10 chains N. of N.E. peg of W.R. 7606, Ravensthorpe
8151	H W B T	13	880	Do.	Western Well on W.R. 7517, Ravensthorpe
8152	H W B T	14	881	Do.	Near S.E. peg of W.R. 8358, Ravensthorpe
8305	H W B T	18	..	Do.	Pipe line, 10 chains W. of N.W. peg of 9977, Ravensthorpe
8306	H W B T	19	..	Do.	S.W. corner of Location 262, Ravensthorpe
8308	H W B T	21	..	Do.	15 chains W. of N.W. peg of Location 2, Cardinup Creek
8309	H W B T	22	..	Do.	Fault on bank of Creek, one mile South of M.H.L. 13
8310	H W B T	23	900	Do.	S. boundary of M.L. 236, Oversight Extended
8314	H W B T	27	965	Do.	M.L. 94, Amazement
8318	H W B T	31	904	Do.	Water Shaft on W.R. 7385
8330	H W B T	43	..	Do.	Road near S. boundary of M.L. 115
8332	H W B T	45	925	Do	20 chains E. of S.E. corner of Recreation Reserve 7369
8563	HPW	..	954	Do. ..	Mt. Benson Mine
8566	HPW	..	963	Do.	Mt. Desmond Mine

1912	TB	..	..	Felsite or fine-grained S. Granite	Half-mile N.E. of Ravensthorpe
1913	TB	..	..	Do. do.	Do.
8315	H W B T	28	..	Do. do.	Felsite Dyke, 20 chains S.W. of M.L. 28, Red Hill
8470	HPW	..	921	Quartz Ceratophyre	Mt. Cattlin Mine
8553	K	..	935	Do.	Do.
				Altered Acid Rocks.	
8562	HPW	..	968	Altered Soda Granite	Mt. Benson Mine
5291	Dr. Ch.	..	..	Sericite Schist	Phillips River
8321	HWBT	34	..	Do.	N.W. corner of M.L. 200, Last Chance Proprietary
8558	HPW	..	..	Do.	Mt. Benson Mine
8564	HPW	..	..	Do.	Do.
7827	M	..	837	Sericite and Andalusite Schist..	Elverdton Mine
8143	HWBT	5	873	Andalusite Rock and Schist ..	2 chains N. of N.W. peg of M.H.L. 126, Ravensthorpe
8463	HPW	..	914	Do.	Sunset Mine
8311	H W B T	24	901	Mica-Chlorite Rock or Schist	Near shaft of M.L. 236, Oversight Extended
8364	H W B T	58	..	Do.	One and a half miles W.S.W. of Kundip Tank
8366	H W B T	60	..	Do.	Mosaic Mine
8567	HPW	..	969	Do.	Mt. Desmond Mine
				Intermediate Rocks.	
1876	TB	..	..	(Quartz) Diorite	Three miles W. of Mt. Desmond
1884	TB	..	979	Do.	Near Dr. Jim Mine
1901	TB	..	970	Do.	Lady Annabelle Lease, Ravensthorpe
7824	M	..	834	Do.	Flag Mine, Kundip
8141	HWBT	3	871	Do.	20 chains E. of S.E. peg of Recreation Reserve, Ravensthorpe
8148	HWBT	10	878	Do.	Two chains from W. peg of M.L. 248, Red Hill
8307	HWBT	20	899	Do.	Dyke, 14 chains N. of S.E. peg of 10336, Ravensthorpe
8313	HWBT	26	902	Do.	25 chains N. of junction of Nangutup and Annabelle Creeks
8316	HWBT	29	923	Do.	Near N.W. corner of G.M.L. 132, Darby

No.	Collector.	F. No.	Section.	Name.	Locality.
				Intermediate Rocks—continued.	
8320	HWBT	33	949	(Quartz) Diorite	N.E. corner of M.H.L. 39
8363	HWBT	57	911	Do.	Dyke, 50 chains W. of Kundip Tank
8554	K	..	950	Do.	Mt. Cattlin Mine, Mullock Dump
8559	HPW	..	972	Do.	Mt. Benson Mine
8562	HPW	..	968	Do.	Do.
8565	HPW	..	791	Do.	Lucy Mine
1888	TB	..	31	Camptonite	Three miles N.E. of Cocanarup
7825	M	..	835	Do.	P.L.P. Lease
7826	M	..	836	Do.	South Cattlin Mine
8145	HWBT	..	875	Do.	Shaft on M.L. 12, Ravensthorpe
8319	HWBT	32	905	Do.	30 chains N. of N.E. peg of M.H.L. 9
8325	HWBT	38	906	Do.	On Creek, 10 chains W. of N.W. peg of M.L. 249, Ravensthorpe
8465	HPW	..	916	Do.	Mt. Cattlin Mine
8469	HPW	..	920	Do.	Do.
8555	K	..	951	Do.	Mt. Cattlin Mine, Mullock Dump
8560	HPW	..	953	Do.	Mt. Benson Mine
8561	HPW	..	967	Do.	Do.
7822	M	..	832	Kersantite	Elverdton Mine
7823	M	..	833	Do.	Mt. Desmond Mine
7912	HWBT	..	947	Do.	Mt. Cattlin Mine
8462	HPW	..	913	Do.	Elverdton Mine
8466	HPW	..	917	Do.	Mt. Desmond Mine
8467	HPW	..	918	Do.	P.L.P. Mine
8468	HPW	..	919	Do.	Elverdton Mine
8557	K	..	952	Do.	Mt. Cattlin Mine, South Lode

				Altered Intermediate Rocks.	
8324	HWBT	37	..	Altered Comptonite or Kersantite	W. bank of Jerducuttup Creek
8464	HPW	..	915	Do.	James Henry Mine
8531	HPW	..	..	Amphibolite	M.L. 110, Grimsley
1874	TB	..	..	Biotite Schist	Mary Mine
1895	TB	..	..	Do.	Federal Lease
1907	TB	..	..	Do.	Dallinson's Claim, Ravensthorpe
1909	TB	..	..	Do.	Kingston Mine
1906	TB	..	..	Garnetiferous Schist	Dallinson's Claim, Ravensthorpe
8533	HPW	..	..	Do.	Mt. Benson Mine
1877	TB	..	..	Garnetif Hornblende Schist ..	Three miles N.E. of Cocanarup
1883	TB	..	72	Garnet Rock	Mt. Cattlin Mine
1911	TB	..	..	Do.	Overshot Hill
2065	the Warden	..	..	Do.	Fitzgerald River
5289	Dr. Ch.	..	..	Garnet Rock Schistose ..	Phillips River
8155	..	17	883	Hornblende Eclogite	35 chains W.N.W. of N.E. peg of M.L. 227, Last Chance
				Quartz Diorites with Chalcedony.	
8149	HWBT	11	879	Quartz Diorite with Chalcedony	Annabelle Creek, W. of M.L. 14
8317	HWBT	30	903	Do.	W.R. 7385
8327	HWBT	40	907	Do.	Near Elverdton Dam
8359	HWBT	53	910	Do.	25 chains N.W. of N.W. corner of G.M.L. 101, Ard Patrick
				Basic Rocks—Diabases, etc.	
6052	M	..	766	Diabase	Last Chance G.M., Mount Desmond
8140	HWBT	2 6	973	Altered Diabase	10 chains N. of N.W. peg of M.H.L. 16, Ravensthorpe
8144	HWBT		874	Diabase	30 chains N.W. of S.E. peg of W.R. 7517, Ravensthorpe
8328	HWBT	41	908	Diabase altered, containing serpentine with bastite	Five chains S. of S.W. peg of M.H.L. 67

PHILLIPS RIVER ROCKS—*continued.*

Rd. No.	Collector.	F. No.	Section.	Name.	Locality.
				Basic Rocks.—Diabases, etc.—continued.	
8568	HPW	..	966	Diabase	Mt. Desmond Mine
8150	HWBT	12	..	Interbanded Acid and Basic Rocks	Annabelle Creek, 3 chains W. of M.L. 14
				Amphibolites, etc.	
8322	HWBT	35	948	Amphibolite	One mile S. of junction of Cardinup and Jerdacuttup Creeks
8154	HWBT	16	882	Serpentine	50 chains W.N.W. of N.W. peg of Quarry Reserve
8326	HWBT	39	924	Do.	Two miles S. of M.L. 266, Grand Seam, 10027
8534	HPW	..	..	Do.	McLeod's "Spec"
7828	M	..	838	Much altered Rock allied to above	Mt. Chester Tunnel
8361	HWBT	55	..	Much altered Rock	Near S.W. peg of T.A. 2
				Pegmatites, etc.	
1855	TB	..	29	Pegmatite	Two miles S.W. of Cocanarup
1856	TB	..	..	Tourmaline Granite	Do.
1860	TB	..	..	Mica Pegmatite	Do.
1863	TB	..	..	Spodumene Pegmatite ..	Half-mile South of Ravensthorpe
1863	M	..	..	Do.	From excavation at Head's Smelter
1878	TB	..	..	Pegmatite	Three quarters of a mile S.S.W. of Ravensthorpe, P.R. M.D.
5281	Dr. Ch.	..	..	Pegmatite	Phillips River
7956	..	..	..	Spodumene in Pegmatite ..	Cattlin Creek, W.R. 17
8529	HWBT	..	..	Pegmatite	W. of M.L. 74, Ravensthorpe
1885	TB	..	..	Jasper Rock	Near Dr. Jim Mine
5290	Dr. Ch.	..	..	Do.	"Phillips River"

				Sedimentary, etc.	
8 46	HWBT	8	..	Ferruginous Sandstone and Conglomerate	35 chains N.E. of S.W. peg of W.R. 7607, Ravensthorpe
8323	HWBT	36	..	Ferruginous Sandstone ..	N. side of Cardinup Creek, 50 chains above junction
8329	HWBT	42	..	Altered Sedimentary Rock ..	M.H.L. 290, King of Iron Knobs
8331	HWBT	44	909	Ferruginous Sandstone ..	E. boundary of Experimental Reserve 9109
8352	HWBT	46	..	Altered Shale or Mudstone ..	10 chains W.N.W. of N.W. corner of C.L. 130, Alice
8353	HWBT	47	..	Ferruginous Sandstone ..	15 chains E.S.E. of S.E. corner of M.L. 235, Victory
8354	HWBT	48	..	Do.	20 chains E.S.E. of S.E. corner of M.L. 242, Lone Star
8355	HWBT	49	..	Partly Metamorphised Sandstone	Near N. corner of G.L. 132
8356	HWBT	50	..	Do. do. ..	At Dam, on T.A. 2, near Flag Mine
8357	HWBT	51	..	Conglomerate	Near above (No. 8356)
8358	HWBT	..	52	Altered Shale	Three chains S. of S. corner of M.L. 251, (216) Harbour View South
8360	HWBT	54	..	Argillaceous Sandstone ..	25 chains W. of N.W. peg of G.L. 107, Ard Patrick
8362	HWBT	56	..	Sandstone	30 chains S. of Kundip Tank
1914	TB	..	..	Quartzite (? a Dyke)	Half-mile N.E. of Ravensthorpe
7811	..	..	..	Saliferous Rock	West River
8312	HWBT	25	..	Travertine with Shells	Salt Pool at junction of Anabel and Nangutup Creeks
6049	M	..	..	Auriferous Ironstone	Mt. Desmond

N.B.—The common rock-forming minerals are omitted from this list, except when cabinet specimens of them are obtainable. Those minerals of which good specimens occur freely are printed in capitals.

Record No.	Dana's No.	Mineral.	Locality.
7098, etc.	13	GOLD	District generally.
4436	31	Tetradymite	G.M.L. 43, Floater, Ravensthorpe.
8404	34	Molybdenite	Near Ravensthorpe.
6229 etc.	54	Chalcosite	G.M.L. 109, Mount Desmond and elsewhere.
6228	67	Covellite	G.M.L. 109, Mount Desmond and elsewhere
..	74	Pyrrhotite	District generally.
7909, etc.	78	Bornite	District generally.
8383, etc.	83	CHALCOPYRITE	District generally.
..	85	PYRITES	District generally.
8091, etc.	96	Marcasite	District generally.
6227, etc.	149	TENNANTITE	Mosaic Mine, Kundip.
7812	166	Halite	West River.
5296, etc.	193	Atacamite	Detected in considerable quantities in several assay samples.
6246, etc.	224	Cuprite	District generally.
6223	230	Tenorite	M.L. 7, Mary
1890, etc.	237	Magnetite	M.L. 143, Kingston Lease, etc.
4444, etc.	269	PSILOMELANE	East of M.L. 112, Mount Desmond.
5436	272	MAGNESITE	Kundip.
8351	288	MALACHITE	District generally.
6728	289	Azurite	M.L 206, Hecla, and elsewhere.
8490, etc.	316	ALBITE	Ravens horpe (Head's Smelter)
7956, etc.	327	SPODUMENE	Ravensthorpe (Head's Smelter).
8125	338	Asbestos (Actinolite)	Phillips River District.
7964, etc.	370A	Grossularite	Near R 2, Cardinup Creek, etc.
8143	398	Andalusite	Near N.W. peg of M.H.L. 12, and Sunset Mine, Ravensthorpe.
8487–9, etc.	426	TOURMALINE, black, green, and pink	Ravensthorpe (Head's Smelter).
1861	458	Muscovite	Two miles S.W. of Cocanarup.
4443	458	Fuchsite	Phillips River.

1858, etc.	460	LEPIDOLITE	Cocanarup and Head's Smelter, Ravensthorpe.
8326, etc.	481	Serpentine	Two miles S. of G.M.L. 266, Grand Slam, etc.
8153	492	Kaolin	Quarry, 1 mile S. of M.H.L. 16, and elsewhere.
7012	493	Halloysite	Ravensthorpe.
8350	561	Olivenite	G.M.L. 99, Alice Mary, Kundip.
8350	601	Erythrite	G.M.L. 99, Alice Mary, Kundip.
8471	814	Scheelite	10 miles S.W. of Kundip and Dallinson's Reward, Ravensthorpe.

PART III.—Description of the Mines.

Historical.—The history of this field may be said to commence in 1892, when the Brothers Stennett discovered gold in small quantities in conjunction with copper and iron pyrites, but owing to the scarcity of fresh water in this locality and to the fact that sensational discoveries were made about this time at Coolgardie, the further prospecting of this district was for the time being abandoned.

The present writer crossed this field upon his way to act as the first Warden of the Dundas about this period, and was so favourably impressed with its mineral character that he strongly recommended further prospecting.

In the early part of 1899, the Dunn Brothers discovered auriferous quartz upon the western edge of the mining belt, not far from their homestead at Cocanarup, where they applied for a lease which they called the Jim Dunn's Wonder, but although the official statistics do not show any return from this lease, it undoubtedly drew attention to this district, for shortly afterwards a large number of others were pegged out and applied for to the northward upon the same line of country.

The original discoveries, as a rule, consist of fragments of auriferous quartz, scattered over a clayey surface, which was mostly covered with dense scrub, whilst the reefs had to be prospected for by trenching.

Prospecting in these early days was conducted under great difficulties on account of the scarcity of fresh water, whilst owing to the fact that the whole area is pretty thickly covered with poison plant, neither horses nor stock could be depastured.

The discovery of this belt of gold reefs was quickly followed by that of the copper lodes in the vicinity of Ravensthorpe, also at the foot of the range to the north-eastward, which are now known as the Mt. Benson group.

In the early part of 1900 Mr. Torrington Blatchford, Assistant Government Geologist, inspected this field, his report upon which, accompanied by a geological sketch map, was published in June of that year as Bulletin No. 5 of this Department.

On account of further discoveries being made during the same year, of the Mt. Desmond and Kundip Centres, a further inspection became necessary; therefore, the services of the present writer were requisitioned, his report appearing in the Annual Progress Report of this Department for 1901.

Early in the year 1903, Mr. A. Montgomery, State Mining Engineer, visited this field with the object of advising the Government regarding the erection of State Smelting Works, and his full report

in pamphlet form was published by the Mines Department in the same year. These smelting works were then erected and run with varying success, first at a position upon the Cordingup Creek, and later at the present site, which is about one mile to the eastward of the town.

The State Mining Engineer's report was supplemented by one dated June, 1905, published in the Annual Report of the Mines Department for 1904, and also by notes on the progress of the State Smelting Works in the Annual Reports for the years 1905 and 1906.

In the year 1906, these works were sold by the Government to the Phillips River Gold and Copper Company, Limited, who have now greatly increased their capacity by the addition of reverberating furnaces and a converter.

Towards the end of 1907, the State Mining Engineer was again despatched to the field with the object of advising the Minister as to whether the prospects of the district warranted the Government in the construction of a railway line from the Coast; his full report appeared in the Annual Report of the Mines Department for 1907. Mr. Cullingworth, the Inspector of Mines, also wrote several reports which appeared in the Press of the same year. Since many of the mines examined and reported upon by these officers are either closed down or an inspection of the upper levels is now impossible, it will assist very greatly in the study of these ore deposits if the reports above referred to are read in conjunction with the present.

The railway line is now an accomplished fact, whilst several good reservoirs have been constructed, which supply water both for domestic and mining purposes.

The Mines.—This field is at the present time passing through a period of extreme depression, which is very generally ascribed to what is called the "slump in the copper market," if, however, the market price obtained for this metal a few years back is recalled, it will at once be apparent that this cannot be the sole reason, since the present price is as high as it was at the inception of the field, the low value being more apparent than real, since it is only comparatively so with the abnormally high figure reached a year or so back.

The low market is, therefore, clearly not responsible for the existing state of things, which may with much greater reason be ascribed to the liberal Government assistance which has enabled men without capital to mine the richest portions of a number of lodes from the surface down to the water level and to dispose of the ore for cash at the State Smelters upon the most favourable terms, the result being that so long as the rich and cheaply worked bunches lasted, a mild boom set in, whilst this was further prolonged by the rise in the copper market above referred to, which rendered much lower grade ore payable.

Upon the top of this boom, certain capitalists secured options over a number of properties and upon these vigorous development

was commenced, with the result that a considerable impetus was given to business in the town, where a large number of new buildings were erected. Owing, however, to the sudden fall in the market, it was found impossible at the time to launch these mines successfully upon the London market, and, in consequence, some have been abandoned, whilst upon the remainder only a limited number of men are employed.

At the present time, a large number of the smaller mines are at a standstill, owing to the fact that the greater portion of the marketable ore above the water level has been raised, whilst funds are not available for the purchase of the necessary machinery to develop them further, the consequence being that the owners have been living in hope that the completion of the railway line would either cause a very considerable reduction in the smelting charges or a revival of interest to take place, which latter would enable them to sell out at a profit, but since these properties have, in the majority of cases, been so favourably reported on officially, a much higher price is expected than there is any likelihood of being obtained.

The condition of the small holders upon this field is, therefore, in a very bad way, which neither the railway line nor cheaper smelting can but temporarily relieve, for if during the boom time the lease owners were unable to purchase plant to work their mines below the water level, they have little prospect of doing so upon the realisation from lower grade ores.

There can be no question but that the future of this field is entirely dependent upon the introduction of outside capital. it is, therefore, to be sincerely hoped that those properties still held by the Phillips River Gold and Copper Company will develop up to expectations, for if such is the case, confidence will be established and many others will be taken up and worked. Should, however, anything unforeseen occur to cause this company to cease operations, this field may be considered as dead, for it would be impossible to induce persons to provide further capital for a considerable time upon the top of an acknowledged failure.

In the description of the mines which follows, the three main centres of Ravensthorpe, Mt. Desmond and Kundip, have been taken separately, whilst the first mentioned of these has been subdivided into three groups, called respectively, the Western, the Central, and the Eastern.

The first of these latter embrace the earliest discovered lodes, which are contained in what may be called the auriferous belt, but since these are now practically abandoned, any reliable information regarding them can only be obtained by reference to the official publications previously mentioned, and this remark also applies to certain of the copper mines in the Central and Eastern Groups of the Ravensthorpe Centre.

Generally speaking, the lodes are of one character, viz., basic intrusions, usually highly ferruginous and siliceous at the surface,

where they are, as a rule, practically destitute of copper, but fairly rich in gold, whilst in the balance of the oxidised zone they may, in addition to gold, carry a considerable percentage of copper, which occurs in the form of ferruginous oxi-carbonates. In the sulphide zone and below the water level, the gold values perceptibly decrease, or practically cease, whilst the copper and iron ores pass directly from carbonates and oxides into primary sulphides, with scarcely any indication of secondary sulphide enrichment.

The richer portions of both the copper and gold lodes above the ground water level, are purely secondary enrichment, lacking both size and definition, and, therefore, cannot correctly be described as shoots, whilst below it, the sulphides are mostly disseminated through a body of lode stuff of considerable size, upon which in only one or two instances, has sufficient development been done to prove their character.

With the exception of the Mt. Cattlin and the Elverdton mines, little has been done below the water level, therefore, it is at the present time impossible to state with any degree of certainty how these ore bodies will behave at a greater depth, but so far as the evidence goes they will, in the majority of cases, prove to be of too limited extent to be payable when the hard country is struck; others again promise to be a fair size, but of very low grade, whilst the remainder which are of considerable size, promise to yield a large quantity of low grade ore suitable for concentration.

Some of the mines are worked exclusively for gold, but these, like those in the Western Group, will, in all probability, make into low grade copper lodes at a depth when, even if the gold values do not fall, the veins are too small and the values too low to be worked profitably in the hard country below the water level.

In the copper mines proper, the ore has, up to the present, been hand picked, the higher grade sent to the smelting works and the more siliceous lower grade, if carrying high gold values, to the battery, by which latter process about 40 per cent. of the contents is recovered, whilst the sands, after passing over Wifley Tables, contain too high a percentage of copper to be amenable to cyanide treatment.

The returns furnished by the various mine owners do not represent the tonnage raised, since a large quantity of the low grade ore is thrown upon one side, whilst the balance is divided into two classes, one called firsts, or copper ore, and the other seconds, or crushing stone. The first of these is sold upon assay and the returns furnished being total metallic contents, whilst the second is crushed at a battery, when the extraction return is given, which, as before stated, is usually only about half of the total gold contents. The concentrates from the battery treatment are also smelted for copper, but the returns under this head do not show the total amount of ore from which they were obtained, but in its place only the tonnage of a concentrated portion, whilst the value given in pounds sterling

does not represent the sum paid for the ore, but the full market price at the time of the metallic copper contents of the ore.

Under the gold returns, upon the other hand, the number of tons crushed are given, but against this only the quantity of gold recovered by amalgamation, which is usually under half the contents. It will be apparent from this that the value of one portion of the ore is over stated, since no deductions are made for loss, but in the second it is not credited with the concentrates which actually are a portion of it, whilst the value of the ore is absolutely fictitious, because it represents the total metallic contents reduced to its highest state of purity upon the London market.

In the following table, the totals show all the ore treated, either by smelting or battery, the gold being the total of the assay returns from account sales notes added to the quantity recovered by amalgamation, and is stated in fraction of ounces per ton, whilst the copper contents is based upon a percentage of the total tonnage treated.

In the grand total for the last eight years of this field's existence, it is shown that the ore which, upon the average, contained 4 per cent. of copper and ½ ounce of gold, may be roughly valued at £4 10s. per ton. The very apparent falling off in the value of the copper ore production for 1908 is more apparent than real, being entirely due to the fact that the smelting works were closed down, therefore little ore was sold, whilst a larger quantity was crushed as seconds.

The usual practice of dealing with such questions as water supply, timber, fuel, fluxes, means of transport, smelting works, machinery and mining methods, together with the class, quantity, and suitability of the ore for smelting, concentration, or other metallurgical treatment, will not be touched upon here, since they have already been so exhaustively reported upon by the State Mining Engineer, to whose province they properly belong.

Table showing the Yield of Gold and Copper from the Phillips River Goldfield.

Year.	Ore treated.	Gold therefrom.	Rate per ton.	Copper therefrom.	Copper value.
	tons.	ozs.	ozs.	tons.	%
1900	34.00	36.72	1.08	10.18	30.00
1901	1,281.14	665.83	0.52	258.54	20.00
902	9,698.50	7,441.30	0.76	23.36	0.24
1903	9,741.08	7,050.73	0.72	214.59	2.20
1904	9,738.49	4,016.63	0.41	485.02	5.00
1905	5,098.54	2,563.26	0.50	307.66	6.00
1906	5,086.68	2,779.89	0.54	287.24	5.63
1907	14,104.62	4,313.87	0.31	658.73	4.67
To June, 1908 ..	3,611.38	1,718.18	0.50	62.95	1.74
Total ..	58,394.43	30,586.41	0.52	2,308·27	4.00

THE RAVENSTHORPE CENTRE.

This centre includes three quite distinct groups of mines which lie round the township from the north-eastward to the south-westward.

The first of these, which may be called the Western group, stretches in one almost unbroken line eight miles in length, which strikes in a north-east and south-west direction, the nearest point of which belt is about two miles north-west of the town.

These mines, without exception, were originally worked exclusively for gold, some of them carrying fairly high values near the surface; at greater depths, however, when the sulphide zone was reached, they invariably become poor.

There are only two in this group worthy of the name of mine, viz.: the Maori Queen and the Floater, the latter being the only one still held, although at present under exemption.

The second or Central group consists entirely of copper mines, which lie scattered in an irregular manner in the zone of dislocation which is situated immediately to the northward of the town, and extends as far as the Mt. Cattlin mine.

This group contains the original copper discoveries of this field and also the deepest mine.

The Eastern group are also copper mines, which lie in the contact zone close to the base of the range, but strike off from it in a westerly direction.

As before stated, the gold mines are practically all closed down, whilst with the exception of one or two of the copper mines they are pretty well in the same condition, the reason in the first-mentioned case being that the values gave out in the hard country, and in the latter practically all the accessible ore has been raised, whilst that in the hard country below the water level cannot be worked without machinery, even if the lode prove to be large and rich, of which in most cases there is very considerable doubt.

The Western Group.—In the greenstone area, which lies to the north-westward of the town, a belt of mines about eight miles in length have been worked for gold.

This group of mines, although the first discovered upon the field, have not as a rule been extensively worked, and are now mostly abandoned owing to the small size of the lodes, the limited extent of the payable stone, and the hardness of the enclosing rock below the water level.

Outcrops are of rare occurrence, the surface being usually covered by a layer of red clay about six feet in thickness, clothed by fairly dense scrub, the only indication of reefs being strewn fragments of quartz.

The lodes in this area are mostly siliceous and much iron-stained enclosed in a solid amphibolite country often intersected by small pegmatite dykes.

At a comparatively shallow depth, and before the ground water level is reached, sulphides of iron and copper make their appearance, and the lode matter passes into a schistose greenstone, whilst gold values materially decrease.

For particulars with regard to them reference should be made to the previous official reports mentioned in the introduction.

Table showing the Yield of the Mines of the Western Group—Ravensthorpe Centre.

Year.	Name and Number of Lease.	Ore treated.	Gold therefrom.	Copper therefrom.
		tons.	ozs.	tons.
1902	Alpha, G.L. 20	10.00	2.63	
1902	All for the Best, G.L. 3 ..	35.00	18.92	
1905–7	Bobby Dazzler, G.L. 115	18.00	38.59	
1902	Bridgetown, G.L. 15 ..	15.00	8.76	
1902	Christiana, G.L. 36 ..	50.00	13.14	
1902	Commonwealth, G.L. 10 ..	60.00	28.91	
1902	Coronation, M.L. 48 ..	31.00	18.14	
1902	Cousins Glory, M.L. 13 ..	80.00	32.46	
1902	Cumberland, G.L. 38 ..	20.00	3.50	
1902–4	Ellendale, M.L. 26 ..	70.00	36.80	
1906	Ellen Tommy, G.L. 93 ..	34.00	14.26	
1904	Eureka, G.L. 64	29.00	33.38	
1901–8	Floater, M.L. 21	12,881.19	10,933.81	.49
1902	Floater Proprietary, G.L.45	30.00	14.89	
1902–3	Golden Link (Day Light), G.L. 63	45.00	30.25	
1902–7	Grafter, M.L. 202	295.65	370.89	1.99
1902	Harwick, G.L. 41	15.00	8.76	
1901–4	James Henry, G.L. 26 ..	406.00	514.67	
1902–5	Jubilee (Diamond Jubilee), G.L. 75	124.00	58.94	
1902–3	Lady Jessie, M.L. 74 ..	77.00	58.43	
1902–4	Lucy, G.L. 21	269.00	174.78	
1902–3	Maori Chief, M.L. 4 ..	22.00	15.54	
1901–7	Maori Queen, G.L. 1 ..	5,086.17	4,100.53	.18
1902–7	Mt. Elya (Princess Royal), G.L. 88	160.50	106.07	
1903–5	Plantagenet, G.L. 76 ..	556.00	185.92	
1902	Sirdar (Two Bobs), G.L. 60	66.00	49.45	
1902	Waratah, G.L. 34 ..	6.00	2.06	
	Total	20,491.51	16,874.48	2.66

Maori Queen, G.M.L. 1. (Plate I.).—This the first gold-mining lease issued in this district, is situated about 2½ miles to the north-eastward of the township. It was worked for some years by the Phillips River Gold Mining Co., N.L., who equipped it with a battery and winding engine, and raised and treated over 5,000 tons of stone.

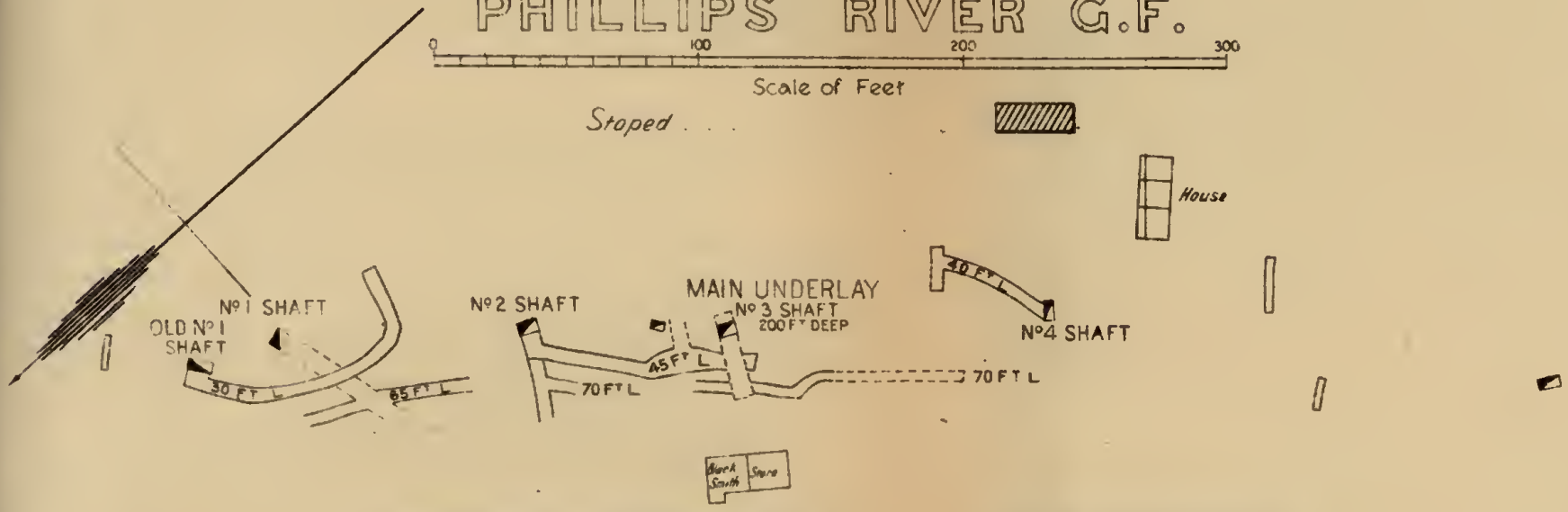
The lode, which has a north-easterly course, has been traced at the surface for a length of 8½ chains by a series of shafts and

PLAN & SECTION OF

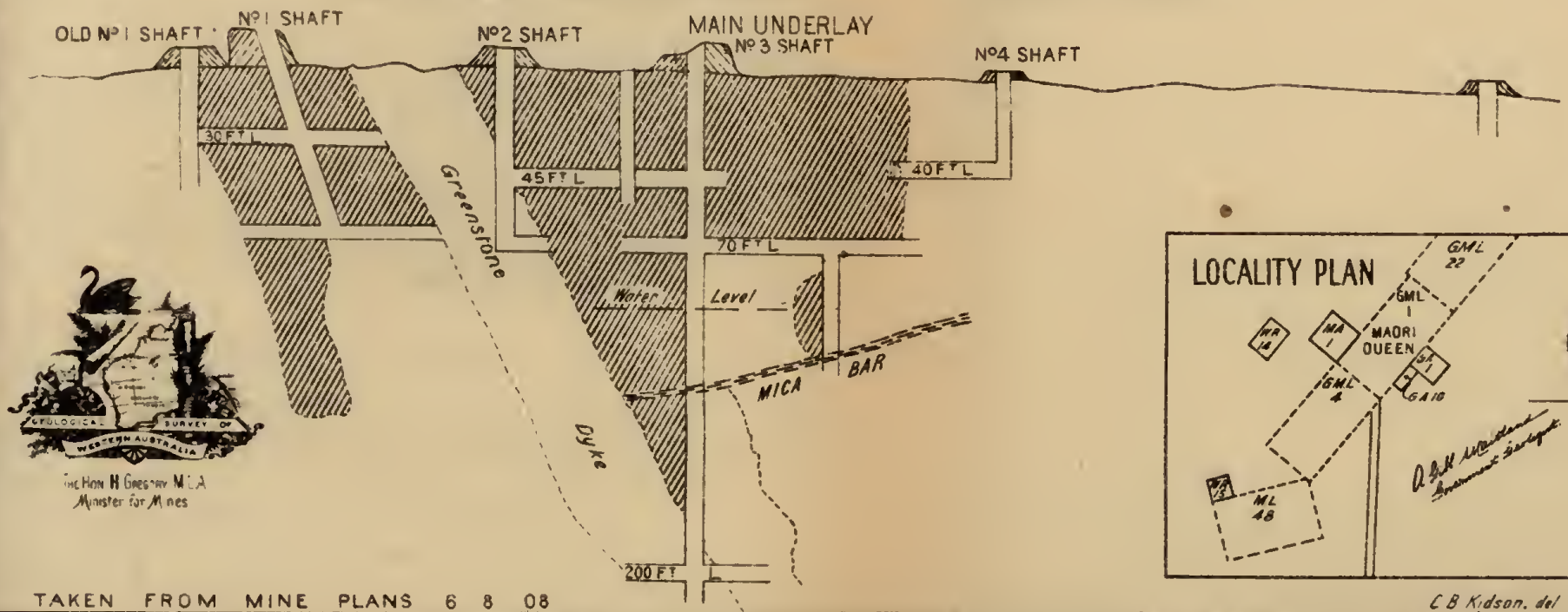
THE MAORI QUEEN

RAVENSTHORPE

PHILLIPS RIVER G.F.



LONGITUDINAL SECTION



The Hon H Gregory M.L.A.
Minister for Mines

TAKEN FROM MINE PLANS 6 8 08

C B Kidson. del

H J Pether, Government Lithographer, Perth, W.A.

trenches, but of this only 280 feet proved to carry high enough values to be payable, whilst in this section the lode was intersected by a dyke of barren rock 40 feet in width.

This reef dips to the north-westward at an angle of 75 degrees to the 70 feet level, below which it pitched and went down nearly vertically.

In the oxidised zone, which extends only to a depth of 30 feet, the lode was about 4 feet in width, but below this it became highly mineralised, and carried a little chalcopyrite, whilst in size it varied from 1 to 4 feet, which became further reduced to from 6 to 18 inches at the bottom of the main shaft. From the surface down to the water level (about 80 feet) that portion of the lode lying to the southward of the dyke has been stoped for a length of 160 feet, but of this only the 40 feet nearest to the intrusion was of high grade, and this portion only was stoped down to the 200 feet level when even this became poor.

In the northern workings the lode has been stoped to the 70 feet level for a length of 70 feet, but below this only the northern section of 20 feet has been stoped down to the 100 feet level.

The footwall of this lode is granitic, and the hanging wall is amphibolite, whilst a large acidic dyke and several small pegmatite veins intersect it.

It has recently been worked in the upper levels by some working miners, but has since been entirely abandoned.

Table showing the Yield of the Maori Queen Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold. therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1901	Maori Queen, G.L. 1 ..	170.00	139.6.	.82
1902	Do.	2,720.00	1,811.14	.66
1903	Do.	1,490.00	1,087.15	.73
1904	Do.	600.00	770.76	1.21
1905	Do.	90.00	240.25	.66
1907	New Maori Queen, G.L. 119	*16.17	51.59	3.20
		5,086.17	4,100.53	.85

*Yielded .18 ton copper.

Plantagenet, M.L. 50.—This old abandoned mine is situated just within the greenstone area, about half-a-mile to the westward of the Maori Queen.

The reef, which strikes in a north-easterly direction, and underlays slightly to the north-west, has been sunk upon at two points to a depth of about 70 feet, the stone being fairly rich near the surface, but became very poor in the sulphide zone which came in below 30 feet. The stone also became more schistose, and very hard, carrying a little chalcopyrite.

Table showing the Yield of the Plantagenet Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1903	Plantagenet, G.L. 50 ..	160.00	109.75	.68
1904	Do.	282.00	53.64	·17
1905	Do.	27.00	9.07	.33
1905	Planet, G.L. 76	87.00	13.46	.15
	Total	556.00	185.92	.33

Grafter, G.M.L. 202.—This lies a short distance to the north-westward of the Plantagenet, and attracted considerable attention in the early days on account of the richness of the stone, the first parcels of which averaged about 3 ozs. of gold to the ton.

There are three lines of lode on this lease, the western one, which strikes north and south with a dip to the westward, has been sunk upon to a depth of about 70 feet; it varies from 12 to 48 inches in width, and is cut through by a small pegmatite vein.

The next vein, which strikes a little to the east of north and dips at an angle of 75 degrees to the westward, has also been sunk upon to a depth of 70 feet; it is a dense quartz, making into foliated greenstone carried between good walls, but although of high grade, it averaged only about one foot in thickness.

The other lode, which had an ironstone outcrop, is called the copper lode, and this has been sunk to a depth of 30 feet, and also crosscut from the 70 feet shaft last mentioned, which is about 30 feet distant. It is about 5 feet in width, but was of low grade; 68 tons of hand picked ore smelted in 1906-7 returned only 3 per cent. of metallic copper.

Table showing the Yield of the Grafter Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1902	Grafter, G.L. 17	66.00	99.34	1.50
1903	Do. do.	125.00	192.15	1.54
1904	Do. do.	36.50	44.94	1.23
1905	Do. do.	..	*20.03	..
1906	Grafter, G.L. 202	8.79	1.76	.20
1907	Do. do.	†59.56	12.67	.21
	Total	295.85	370.89	1.29

* From cyanide. † Yielded 1.99 tons of copper.

Floater, G.M.L. 82 (Plate II.).—This mine was called the Floater by the original prospectors from the fact that no reef out-

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THE HON. H. GREGORY M. L. A.
Minister for Mines.

PLAN & SECTION OF

THE FLOATER MINE

RAVENSTHORPE

PHILLIPS RIVER G.F.

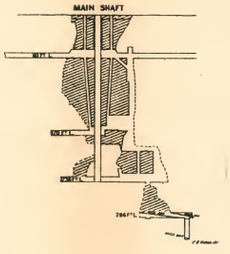
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LONGITUDINAL SECTION



A. Gibb Maitland
Government Geologist

TAKEN FROM MINE PLANS.

H. J. Pether, Government Lithographer, Perth, W. A.

cropped, but some fairly rich specimens of auriferous quartz were discovered lying about upon the surface (called "floaters"), the vein from which they were derived being only located after some 6 feet of clay was sunk through.

It is situated about 2¼ miles north of Ravensthorpe, and has been held for some years past by the Gilbert Gold Mines, Ltd., who have equipped it with a battery and winding engine.

The reef proved to have an easterly course and to go down nearly vertically, but although it was traced at the surface for a considerable distance by trenches and shallow shafts, it was only rich for a short distance. The zone of enrichment goes down nearly vertically, but with a slight pitch to the eastward; it averages 70 feet in length and 8½ feet in thickness, and has been followed down for a depth of 316 feet.

A main vertical shaft has been sunk in the ore body to a depth of 236 feet, from which the lode has been worked by three levels, the No. 1, or 60 feet, has been driven for a distance of 120 feet north and 240 feet south in payable ore for a length of only 68 feet.

Above this level the stone was mostly quartz, much ironstained, and often showing a considerable quantity of gold, but below this its character changed to the typical schistose greenstone containing sulphides of iron and copper and in places a little telluride of bismuth. It also contains quartz in veins and bunches often firmly attached to the walls of the lode, which are irregular and show no signs of movement. The lode was intersected at several points by thin flat veins of pegmatite, called mica bars owing to the fact that they consist largely of that mineral.

The ore body attained its maximum longitudinal extent at a depth of 110 feet, where it was 104 feet in length, below which it rapidly diminished, being 64 feet at the 236 feet level and only 44 at the winze bottom, which is 286 feet below the surface.

The gold values also steadily decreased with depth, starting at 1.14ozs. per ton in the upper levels and falling to .12oz. at the bottom.

Table showing the Yield of the Floater Mine.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1901	Floater, G.L. 43	*49.19	104.79	2.13
1902	Do. do.	3,558.00	4,060.28	1.14
1903	Do. do.	5,740.00	4,9 9.32	0.85
1904	Do. do.	3,135.00	1,628.99	0.52
1905	Do. do.	151.00	62.89	0.41
1906	Do. do.	96.00	88.87	0.92
1907	Floater, G.L. 82	140.00	59.60	0.42
1908	Do. do.	12.00	19.07	1.59
	Total	12,881.19	10,933.81	0.58

* Yielded 0.49 ton of copper.

James Henry, G.M.L. 26.—This is one of the typical auriferous lodes of the district, the character of which is that they do not outcrop at the surface, where the only indication of their presence was given by strewn quartz fragments containing gold.

Beneath a few feet of clay the cap of a ferruginous quartz reef was discovered, which had a strike of about 35 degrees east of north and a dip of from 75 to 80 degrees to the westward.

A main shaft has been sunk to a depth of 126 feet in a massive hornblende rock containing large crystals of that mineral, brackish water being struck at a depth of 90 feet, which made at the rate of 4,000 gallons in the 24 hours.

At a depth of 80 feet a level was driven for a length of 80 feet, in which the payable ore was 65 feet in length and averaged about 2 feet in width. This body, which has apparently a northerly pitch, is said to have been stoped up to the surface, but cannot have averaged more than one foot in thickness if the tonnage reported as raised from this mine is correct.

The upper portion of this lode was oxidised, but from 40 feet or 50 feet down it contained large quantities of iron and a little copper pyrites.

A small western vein has also been worked by an opencut, and several small shafts to a depth of 40 feet. This underlies to the southward, or towards the other lode, whilst it strikes almost east and west, and therefore should junction with it a few chains north of the workings.

Table showing the Yield of the James Henry Mine.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1901	James Henry, G.L. 26 ..	22.00	68.41	3.11
1902	Do. do.	210.00	214.35	1.02
1903	Do. do.	99.00	141.77	1.43
1904	Do. do.	75.00	90.14	1.20
	Total	406.00	514.57	1.26

Lucy, G.M.L. 21.—This old abandoned lease, which was previously known as the Lady Annabel, was worked by two shafts, one 120 feet and the other 100 feet in depth.

At this level the lode, which averaged about 3 feet 6ins. in width, has been driven on for a distance of 100 feet and portions of it stoped up to the surface.

The lode did not outcrop, but was covered by several feet of earthy detritus; it proved to have a strike of north-east with a dip of about 80 degrees to the westward, and to consist of a highly ferruginous quartz down to the water level (30 feet), below which

it changed into a heavy pyritic body carrying a little copper, the enclosing rock being a dense amphibolite.

From this mine 269 tons of stone were crushed, which yielded 174.78 ounces of fine gold, or at the rate of .65 ounce per ton, there apparently being no record of the sands treated.

Table showing the Yield of the Lucy Mine.

Year.	Name and Number of Lease.	Ore Crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1902	Lucy, G.L. 21	68.00	59.57	0.87
1903	Do. do.	151.00	89.61	0.59
1904	Do. do.	50.00	25.60	0.51
	Total	**269.00**	**174.78**	**0.65**

The Central Group.—This group of mines are situated in the intrusive greenstone areas, close to and upon the northern and north-western side of the township, the lodes in which often occur at the contact with the granite.

The lodes are of the usual basic dyke order, containing a considerable quantity of quartz in the upper levels, which is apparently of metasomatic origin, as probably is the gold also to a very considerable degree.

One of the striking features of these lodes is the occurrence of primary sulphides quite near the surface and considerably above the ground water level, whilst like the other lodes of the district, metallic copper, oxides, and secondary sulphides are rarely present.

In the oxidised zone the carbonates may occur in a fairly concentrated form, but this is rarely the case with the sulphides, which are more disseminated throughout the entire lode mass, whilst when they do occur as veins or bunches, they often consist largely of iron sulphides, the result being that the general grade in copper is low, but since the cupriferous formations are usually of considerable size this trouble can be overcome by concentration.

Generally speaking these mines have passed beyond the means of working miners, since capital is required for their further profitable development.

The large output from the Cattlin mine in 1906/7, when the price of copper was phenomenal, has placed the production of this portion of the district ahead of the others, but at the same time, on account of the low grade of the ore raised, the average percentage was decreased, thus the 10,700 tons of ore only returned an average of 7 per cent.

Table showing the Yield of the Mines of the Central Group—Ravensthorpe Centre.

Year.	Name and Number of Lease.	Ore treated.	Gold therefrom.	Copper therefrom.
		tons.	ozs.	tons.
1907	Andante, M.L. 207 ..	17.00	6.60	..
1904–7	Copper Horseshoe, M.L. 244	14.98	..	2.03
1901–3	Grimsby, M.L. 110	5.85	..	0.59
1901–8	Marion Martin, M.L. 16 ..	1,460.79	56.48	167.36
1902–7	Mt. Cattlin, M.L. 15	8,102.99	1,890.83	433.96
1901–7	Mt. Cattlin West (Zealandia, Puzzle and Puzzler), M.L. 219	127.02	0.59	21.87
1903–7	Sunset, M.L. 115	507.44	..	52.34
1901–7	Surprise, M.L.114	466.46	..	56.81
1904	Turn of the Tide, M.L. 166 ..	4.21	..	0.25
	Total	10,706.74	1,954.50	735.21

Mt. Cattlin Copper Mine, M.L. 15 (Plate III.).—This, the largest and most highly developed mine upon this field, is situated about one mile north of the township of Ravensthorpe, and for many years, in fact up to the time it was acquired by the Phillips River Gold and Copper Co., little ore had been raised owing to the fact that it was not generally of a sufficiently high grade to pay for treatment at the then low value of copper. As, however, fairly extensive development had taken place, the company were in a position to take advantage of the rise in the market by putting out 7,621 tons of 5½ per cent. ore.

This mine has now been opened up by four levels, the 100 feet, or No. 1, being 740 feet in length; the 200, or No. 2 level, 640 feet in length; the No. 3, or 300 feet level, 460 feet; whilst at the No. 4, or 400 feet level, the lode has so far only been driven on for a length of 200 feet.

In these levels a large formation, which varies from 4 to 30 feet in width, has been driven on and crosscut, the highest grade portions being apparently confined to four zones, which pitch to the south-west.

This lode, which has a course of north 63 degrees east and practically a vertical dip, is a cupriferous basic dyke, some few feet of which in the bottom levels is often of high grade and exhibits a foliated structure consisting of bands of greenstone, quartz, and chalcopyrite, whilst the poorer portions are composed of greenstone and quartz with pyritic minerals in splashes or disseminated throughout the entire mass, these latter consisting of pyrrhotite, marcasite, and chalcopyrite.

In this mine the oxidised zone only extends downwards for 54 feet, below which the primary sulphides were met with without any appreciable zone of secondary enrichment, what little has taken

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PLAN & SECTION OF
THE Mt CATTLIN MINE

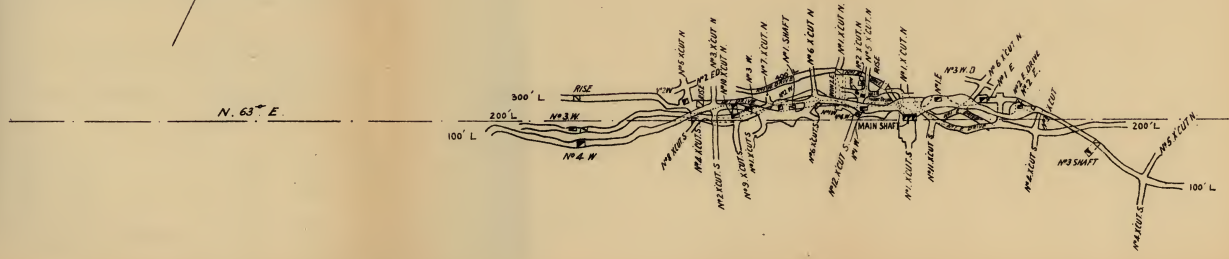
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RAVENSTHORPE

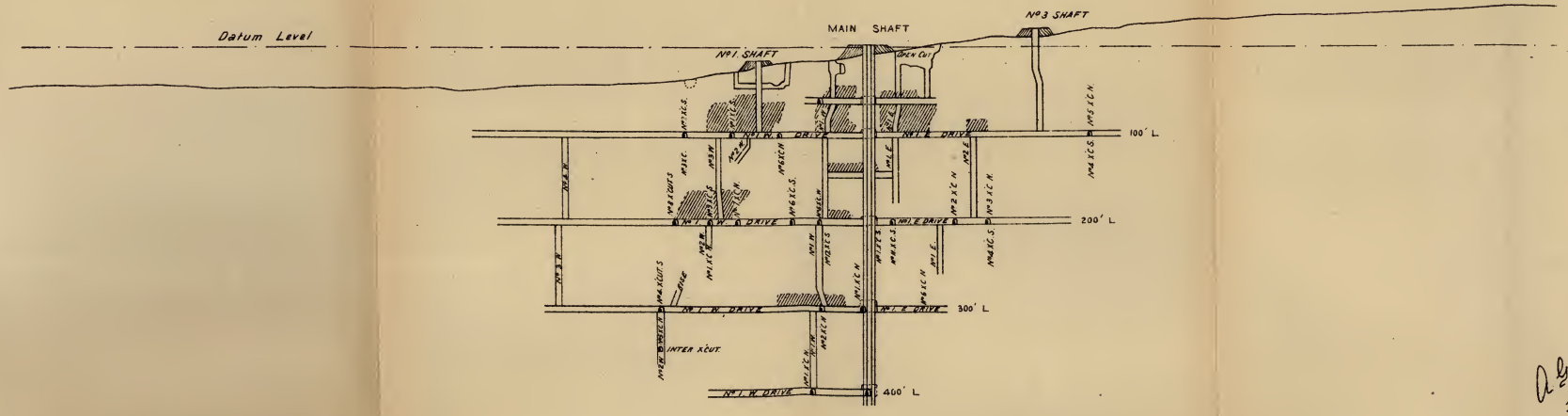
PHILLIPS RIVER G.F.

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Scale of Feet.

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LONGITUDINAL SECTION



A. Gibb Maitland
Government Geologist.

TAKEN FROM MINE PLANS, 31. 3. 08.

C.B. Kidson del.

H. J. Pather Government Lithographer Perth W.A.

place being confined to the dislocation or fracture planes in the lode, which have allowed free passage to the downward flow of circulating waters.

Taking the lode all through it is a large low-grade pyritic body, in which the zones of higher value run in shoots which pitch to the westward, and which, although not of so high a value in the bottom as in the upper levels, there is every indication of the length of the shoot increasing; the ore from it will all, however, require crushing and concentrating before smelting.

The gold values in this mine have always been a considerable factor, amounting to something like 5dwts. to the ton of ore treated; how this, which practically all comes from above the 200 feet level, compares with the 400 feet is only known to the company, but it is probable that a considerable diminution will have taken place, whilst below the circulation of the ground waters it will probably be carried only in negligable quantities.

In the upper levels the lode is enclosed by massive hornblende country upon the south, and garnet rock upon the north, whilst in the deeper levels the south wall is a fine grained amphibolite, and that upon the north a coarse crystalline hornblende rock.

It is crossed by an acid dyke, which intersects it between the Nos. 1 and 2 shoots without causing any deflection of the line, whilst this body is apparently decreasing in width with depth.

In sinking the main shaft from the 300 feet to 400 feet level a fissure was encountered from which so heavy a flow of water was emitted that the workings were flooded, and when this was overcome so far as the levels were concerned, it was found to be quite impossible to proceed with the shaft sinking in this fracture zone, therefore a winze was sunk in the solid country about 50 feet farther to the westward and the level driven back under it which allowed large pumps to be installed before the fissures were tapped and the shaft drained.

Table showing the Yield of the Mt. Cattlin Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold therefrom per ton.	Copper therefrom.
		tons.	ozs.	%
1902	Mt. Cattlin, M.L. 15	2.50	..	20.00
1903	Do. do.	18.63	0.03	14.76
1904	Do. do.	78.29	0.25	12.51
1905	Do. do.	382.14	0.17	5.00
1906	Phillips Gold and Copper Co., Ltd., M.L. 15	1,263.76	0.30	6.43
1907	Mt. Cattlin Copper Mining Co., Ltd., M.L. 15	6,357.67	0.23	5.07
	Total	8,102.99	0.24	5.33

Average value of ore, £5 12s. 6d. per ton.

Mt. Cattlin West, M.L. 219.—Upon this lease, which has been previously known as the Zealandia, Puzzle and Puzzler, and which lies about ¼ mile to the south-west of the Mt. Cattlin, a cupriferous dyke, striking in a north-westerly direction and dips at a high angle to the north-east, has been developed to a depth of 105 feet by an underlay shaft, sunk upon the hanging wall side of a large formation.

In this shaft, the ground water level was originally cut at a depth of 75 feet, but since the Cattlin has been unwatered at the lower levels, this has now receded to the 100 feet level.

At the 45 feet level the vein which was much broken, has been driven on in an easterly direction for a distance of 25 feet, whilst at the 70 feet level the formation has been crosscut in a north-easterly direction for a distance of 27 feet.

At the 100 feet level, a crosscut has been driven north-easterly 40 feet, a winze sunk 14 feet and a rise put up 18 feet, upon a rich portion of the lode, which was at this point 10 feet in width. A level has also been driven 40 feet in a westerly direction, upon a small vein of ore on the hanging wall side of the formation.

Some very rich bunches were worked in the carbonate zone, which extended to a depth of 60 feet, below which, however, the sulphides, as a general rule, are more generally disseminated throughout the formation, although zones of enrichment also occur particularly upon the walls, which latter are at present the only portions that are of high enough grade to smelt without concentration.

Table showing the Yield of the Mt. Cattlin West Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Zealandia, M.L. 46	39.75	..	28.67
1903	Do. do.	19.11	..	9.26
1904	Puzzle, M.L. 189	32.94	..	14.29
1905	Puzzler, M.L. 219	9.86	..	14.09
1906	Puzzler, M.L. 219	2.58	..	13.56
1907	Mt. Cattlin West, M.L. 219 ..	22.78	.03	9.87
	Total	127.02	..	17.14

Average value of ore, £9 per ton.

The Copper Horseshoe, M.L. 244.—This lode which strikes in a north-easterly direction for a length of about 5 chains, is situated about 60 chains to the south-westward of the Mt. Cattlin.

It has been opened by a main shaft to a depth of 98 feet, in which the permanent water level was cut at 80 feet.

It is a small vein, which varies from 6 inches to 2 feet in thickness, and carried carbonates of copper in bunches for a length of 30 feet, which has been stoped up from a depth of 20 feet to the surface, the sulphides beginning to show at a depth of 25 feet, below which the country is very hard.

A total of 15 tons of ore has been raised from this mine, which averaged 13½ per cent. of copper, which was valued at £104.

Marion Martin, M.L. 16.—This mine, which is situated in the greenstone area, near the north-western corner of the township, has been worked more or less consistently from 1901 to 1905, after which it passed into the hands of the Phillips River Gold and Copper Company, who raised a certain amount of ore in 1907, since which it has been let to tributers.

There are at least four lines of lode upon this lease, but although the ore in the oxidised zone was of good grade, the veins were small, whilst the parcel raised by the Company showed a considerable falling off in value from those previously treated.

For full particulars *see* the State Mining Engineer's reports.

Table showing the Yield of the Marion Martin Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Marion Martin, M.L. 16 ..	75.00	..	18.18
1903	Do. do.	138.95	..	15.02
1904	Do. do.	322.49	.02	16.04
1905	Do. do.	329.25	.03	13.46
1907	Phillips River Gold and Copper Co., Ltd., M.L. 16	566.61	.06	5.09
1908	Phillips River Gold and Copper Co., Ltd., M.L. 16	28.49	.02	11.12
		1,460.79	.04	11.46

Average value of ore, £7 per ton.

Sunset, M.L. 115.—This mine is situated at the north-western corner of the township of Ravensthorpe, and, although in the greenstone area, granite makes its appearance at the bottom level upon the northern side of the lode, which has been sunk upon to a depth of 130 feet, one hundred feet of which is by shaft and the last thirty feet by winze.

The lode at the western end strikes west-north-west, but turns more to the south-east at the eastern end, whilst the dip, which is nearly vertical, is slightly inclined to the south in the upper workings, but turns over to the northward in the lower.

No water has been cut in this mine up to the present, but in spite of this fact, the oxidised zone only descended to a depth of

40 feet, below which chalcopyrite was met with, the matrix of the ore being ferruginous and siliceous in the upper levels and dense siliceous greenstone in the lower.

The shaft was sunk in ore all the way from the surface, the rich portion, which was from 35 to 40 feet in length and varied from 3 to 5 feet in width, has been stoped up from the 70 feet level, below which the matrix proved to be too hard to work profitably by hand.

At a depth of 100 feet there is a bunch of ore 10 feet in width, which great size is apparently due to the junctioning of a branch vein, which joins it from the southward, whilst in the level which has been driven for a distance of 15 feet east and 8 feet west, the entire formation is only 8 feet in width.

At a depth of 60 feet, a level has been driven for a distance of 50 feet in a south-easterly direction to another shaft, from which a portion of the vein has been worked up from a depth of 50 feet, which averaged 4 feet in width and carried rich bunches of carbonates of copper. There is a considerable quantity of low grade ore in the dump.

Table showing the Yield of the Sunset Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1903	Sunset, M. L. 115	65.36	..	12.85
1904	Do. do.	286.30	..	10.21
1905	Do. do.	87.00	..	11.09
1906	Do. do.	39.10	..	7.24
1907	Do. do.	29.68	..	7.51
	Total	507.44	..	10.31

Average value of ore, £6 10s. per ton.

Surprise, M.L. 114.—This mine adjoins the Sunset upon the west, and is possibly the same line of contact fissure, although it has, so far, not been traced. The lode, which did not outcrop at the surface, has an east and west course, with a dip of about 75 degrees to the northward, consisting, when first cut at a depth of 3 feet, of 20 inches of ferruginous carbonate of copper and three feet of weathered formation, which diminishes in size with depth, but becomes more defined and has a good footwall.

A main shaft has been sunk to a depth of about 80 feet upon the underlay, from which depth the lode has been followed by a winze to a further depth of about 40 feet, in which the ore body is about 8 feet in width, containing chalcopyrite in too disseminated a state to be smelted without concentration.

At a distance of 120 feet farther to the westward another shaft has been sunk upon the same vein which here carried rich, but small bunches of carbonate ore.

Like the Sunset, the country was extremely hard in the lower levels, and in consequence did not pay, and, therefore, since practically all the marketable ore in sight has been worked out, this mine is now at a standstill.

Table showing the Yield of the Surprise Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Surprise, M.L. 114	5.50	..	18.18
1904	Do. do.	153.96	..	15.44
1905	Do. do.	61.42	..	14.96
1906	Do. do.	175.19	..	9.07
1907	Do. do.	20.39	..	34.04
	Total	466.46	..	12.17

Average value of ore, £8 per ton.

The Eastern Group.—This group of mines is situated about three miles to the north-eastward of Ravensthorpe, close to a low range of foot hills, which run in a north-westerly direction, known as Mt. McMahon.

These mines follow on east and west belt of country, which starts close to the range where the rocks are of a highly schistose character, containing parallel zones or beds, in which ferruginous concentration has taken place.

The central and western portions of this group are in greenstone country, the rocks of which have been intruded into the granite area.

The lodes in the schistose area have usually a north-westerly course, with a south-westerly underlay and are of considerable longitudinal extent, whilst those in the greenstone area are mostly short, extremely irregular, and most usually occur at or near the contact of the greenstones with the granite.

About 3,700 tons of 12 per cent. copper have been raised from these mines, but at the present time very little work is being carried on since the Phillips River Gold and Copper Company have closed down the Mt. Benson, because they failed to locate the lode at a depth by boring, whilst upon the other lease little more can be done without machinery, for which the necessary capital is not at present forthcoming.

Table showing the Yield of the Mines of the Eastern Group—Ravensthorpe Centre.

Year.	Name and Number of Lease.	Ore treated.	Gold therefrom.	Copper therefrom.
		tons.	ozs.	tons.
1903-7	Ballarat (Emily Hale), M.L. 205	252.58	..	34.81
1904-8	Birthday (Duke of York, Mt. McMahon), M.L. 259 ..	18.11	..	2.22
1904-7	Contest (Federal), M.L. 196 ..	24.36	0.21	2.88
1901-7	Last Chance, M.L. 116 ..	874.99	5.31	140.20
1906	Last Chance Ext., M.L. 227	2.55	..	0.34
1901-7	Last Chance Prop., M.L. 200	278.94	..	32.00
1901-7	Mary, M.L. 7	795.74	9.47	109.70
1900-7	Mt. Benson (Kingston) M.L. 175	1,333.99	508.23	119.15
1904-7	Mt. Benson Ext. (Blue Ribbon) M.L. 195	34.12	11.88	3.49
1903-8	New Moon (Kilmore), M.L. 204	125.33	0.70	17.47
1903	Nil Desperandum, M.L. 133 ..	4.26	..	0.34
1907	Our Selection, M.L. 276 ..	10.89	..	0.98
1906	Who Can Tell, M.L. 221 ..	1.45	..	0.16
	Total	3,757.31	553.80	463.74

Mt. Benson Copper Mine, M.L. 175 (Plate IV.).—This mine which was originally a portion of the Kingston mine, is owned by the Phillips River Gold and Copper Company, Limited, and is situated nearer the western end of this group of mines at the contact of the greenstones with the granite.

No official report exists upon this mine, and since it is at present closed down, no examination can be made, a plan of the workings is, however, attached, which will give an idea of their extent.

Table showing the Yield of the Mt. Benson Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1900	Kingston, M.L. 10	11.00	0.47	31.50
1903	Mt. Benson, M.L. 175 ..	106.20	..	14.14
1904	Do. do.	120.94	0. 2	11.17
1905	Do. do.	364.68	0.48	12.13
1906	Do. do.	13.37	..	5.83
1906	Phillips River Gold and Copper Co., Ltd., M.L. 175 ..	84.50	0.48	10.66
1907	Phillips River Gold and Copper Co., Ltd., M.L. 175 ..	633.30	0.27	5.26
	Total	1.333.99	0.38	9.00

Average value of ore, £7 per ton.

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The Hon. H Gregory, M. L. A.
Minister for Mines

PLAN & SECTION OF

THE Mt BENSON MINE

MINERAL LEASE 175

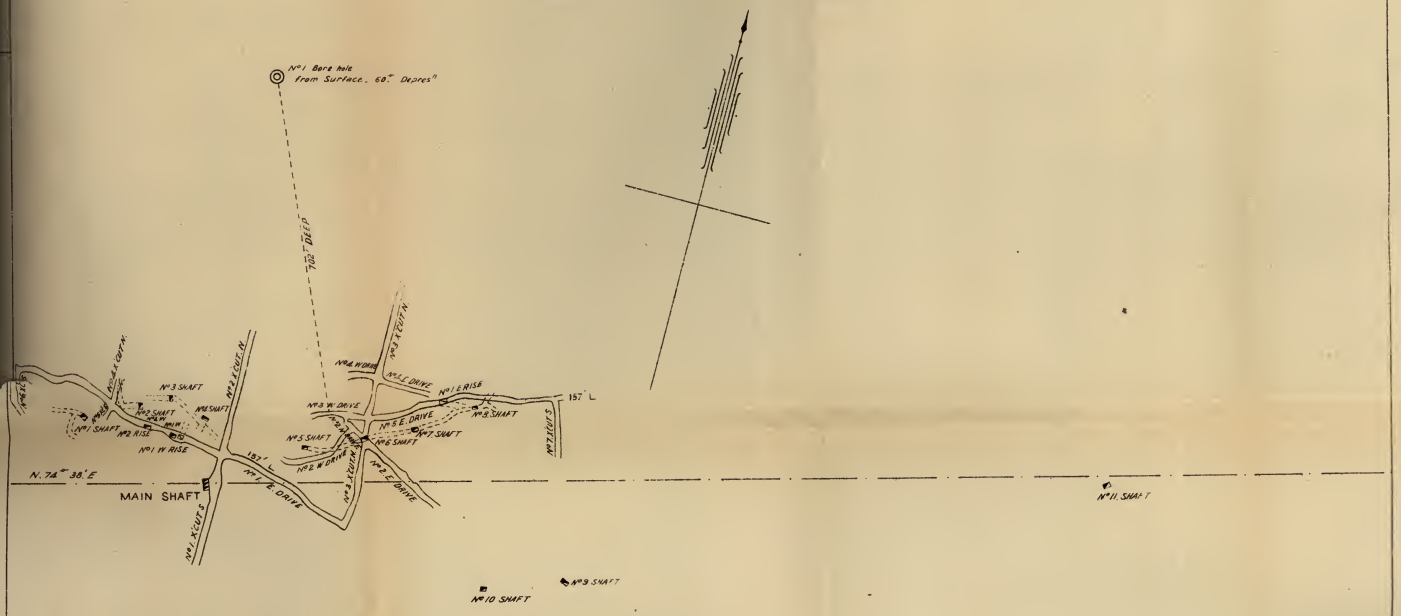
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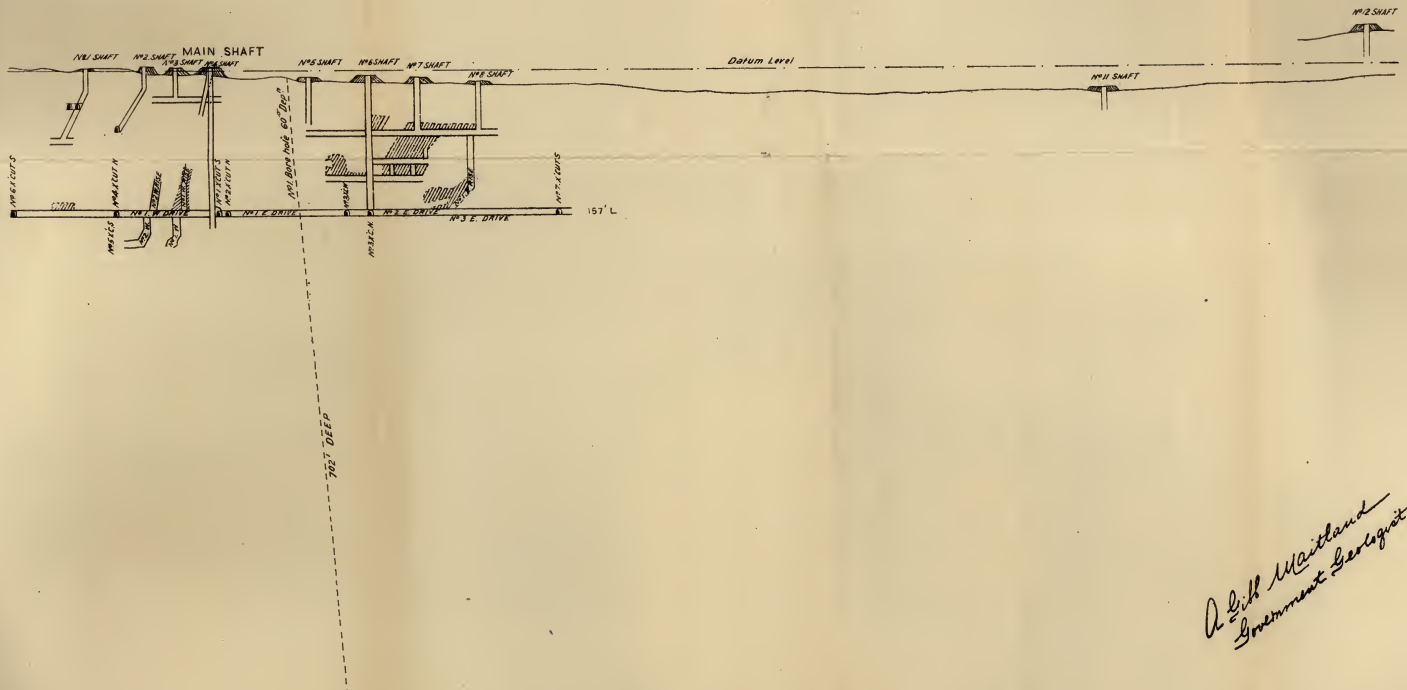
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Scale of Feet.

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LONGITUDINAL SECTION



A Gill Maitland
Government Geologist.

TAKEN FROM MINE PLANS 31. 3. 08.

C. B Kidson. del

Table showing the Yield of the Mt. Benson Extended Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1904	Blue Ribbon, M.L. 176 ..	11.35	.37	15.58
1905	Mt. Benson Extended, M.L. 195	2.55	0.50	16.50
1907	Do. do. ..	20.22	0.52	6.42
	Total	34.12	0.47	10.23

Mary Copper Mine, M.L. 7.—This lease is situated and adjoins the Mt. Benson upon the east, and upon it a considerable quantity of work has been done to a shallow depth on a series of copper lodes.

This mine is not being worked at present, whilst the most recent official report upon it appeared in the report on the Phillips River Goldfield by Mr. A. Montgomery, State Mining Engineer, issued by the Mines Department in 1903.

Table showing the Yield of the Mary Mine.

Year	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Mary, M.L. 7	32.90	..	22.19
1903	Do. do.	239.53	..	13.23
1904	Do. do.	327.24	0.02	13.91
1905	Do. do.	167.75	0.01	13.46
1907	Do. do.	27.32	..	8.05
	Total	795.74	..	13.78

Average value of ore, £4 2s. 0d. per ton.

Ballarat Copper Mine, M.L. 205.—This property, which is situated about half a mile south-east of the Mt. Benson, and west of the Last Chance Proprietary, includes the Emily Hale, M.L. 124, upon which lease the workings are located.

The lode has a general north and south strike with an underlay to the westward, its dip being at an angle of 45 degrees down to a vertical depth of 40 feet from which it pinches, and is followed down by the shaft for 20 feet, when it again assumes its old grade, and has been followed upon the underlay for a further depth of 50 feet.

At the bottom of this underlay it has been driven upon for a distance of 45 feet in a northerly direction, the lode consisting of sulphide ore about 4 feet in width in a hard greenstone rock, there being no defined walls until near the face, when the lode takes a turn to the north-west following the foliation of the rocks.

South from the shaft the lode is broken, but a crosscut 15 feet in length encountered another vein which followed a north-westerly course. This vein, although small, has been driven upon for a distance of 20 feet, in which it shows well defined walls and dips at a steep angle to the westward.

All the stoping has been done at and above the 65 feet level, which has been driven upon the vein for a distance of 90 feet south and 100 feet north. From the south drive a body of sulphide ore from 2 to 6 feet in thickness has been underhand stoped for a length of 40 feet to a depth of 15 feet and stoped up for 25 feet. The carbonate ore has been worked from the surface down to the 40 feet level, or about 60 feet on the underlay for a length of 40 feet, the ore body averaging about 3 feet in thickness, but it is not well defined.

The lode has been traced at the surface by trenches in a southerly direction for a distance of 132 feet, whilst in a pot hole, about 100 feet to the north-east, a vein about 3 feet in width is exposed, which should junction with the first-mentioned near the main shaft.

The water level was originally cut at a depth of 65 feet, while the sulphides came in, but since the Mt. Benson deeper levels were driven this mine has become quite free of water.

Table showing the Yield of the Ballarat Mine.

Year.	Name and number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1903	Emily Hale, M.L. 24 ..	51.40	..	15.93
1904	Do. do.	14.53	..	14.04
1905	Do. do.	29.56	..	17.66
1906	Do. do.	36.78	..	16.25
1906	Ballarat, M.L. 205	54.81	..	13.93
1907	Do. do.	65.50	..	9.00
	Total	252.58	..	13.78

Average value of ore, £10 per ton.

The Kilmore, now *New Moon*, M. L. 204.—This lease is situated upon the south side of this belt, about half a mile south-east of the Mt. Benson Mine, and adjoining the Ballarat upon the south-west.

The workings consist of a number of shafts sunk upon an ore channel to a depth of 40 feet at the contact of the greenstones, with the granite in which the ore occurs in a number of small rich veins.

At the bottom level the sulphides begin to make their appearance, but have not paid to work so far as the country is hard.

In the oxidised zone the ore channel consists of 20 feet schistose material 13 feet in width, the ore being carbonate of copper with oxide of iron.

Altogether rather above 125 tons of 14 per cent. ore have been raised, valued at £1,089.

Table showing the Yield of the Kilmore Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1903	Kilmore, M.L. 119	31.92	..	17.00
1904	Do. do.	29.77	..	13.20
1905	Do. do.	11.09	..	12.26
1906	Do. M.L. 204	23.71	..	10.67
1907	Do. do.	21.80	0.70	14.17
1908	Do. do.	7.04	..	16.47
	Total	125.33	..	13.93

Average value of ore, £8 per ton.

Last Chance, M.L. 116.—This the easternmost lease of this group which is situated in the schistose area close to the base of a steep hill ridge, which lies parallel to the Ravensthorpe Range.

The lode, which has a course of a little north of west, dips at an angle of 75 degrees to the south-westward, has been sunk on to a depth of 120 feet; very little work has been done below the water level, which is about 65 feet, since the ground is extremely hard, and the ore, which is chalcopyrite, being disseminated throughout the lode mass thus requiring concentration.

Above the water level the lode has been driven upon for a length of 400 feet, where it is well defined with good walls, and averages from 3 to 4 feet in width, whilst from this level several stopes have been worked up to the surface, from which about 875 tons of 16 per cent. ore have been mined.

Table showing the Yield of the Last Chance Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Last Chance, M.L. 116 ..	13.50	..	27.77
1903	Do. do.	150.71	..	17.03
1904	Do. do.	374.43	0.01	15.65
1905	Do. do.	75.58	0.01	16.14
1906	Do. do.	158.18	..	16.72
1907	Do. do.	102.59	..	13.16
	Total	874.99	..	15.02

Average value of ore, £9 12s. 6d. per ton.

Last Chance Proprietary, M.L. 120.—This mine is situated westward of the Last Chance, just within the schistose area, but close to its contact with the granite.

The lode, which has a course a little to the west of north, with a dip of about 70 degrees to the westward, has been sunk upon to a depth of 125 feet, from which level a winze has been sunk for a further depth of 90 feet upon an ore body, which pitches to the southward, consisting of quartz, chalcopyrite, and marcasite, with a little covellite coating about 3 feet in width.

In the 65 feet level, from above which most of the ore, consisting of carbonates, has been raised, the lode is 3 feet in width, and is enclosed between two well-defined walls in schistose country.

Table showing the Yield of the Last Chance Proprietary Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Last Chance Prop.. M.L. 120	3.50	..	14.30
1902	Do. do. ..	12.00	..	14.58
1903	Do. do. ..	6.49	..	11.00
1904	Do. do. ..	12.88	..	12.20
1905	Do. do. ..	17.32	..	13.16
1906	Do. do. ..	84.49	..	13.14
1907	Do. do. ..	136.24	..	10.30
	Total	272.94	..	11.72

Average value of ore, £9 per ton.

THE MOUNT DESMOND CENTRE.

This group, or more correctly speaking, line of mines, is situated in a granitic belt of country close to its contact, with the greenstones which lie at the base and upon the western side of the Ravensthorpe Range.

These rocks, which are often schistose at the surface and always massive below the water level, are traversed by two series of large dykes, the first of which usually follows a north-westerly course and are of a basic type, whilst the other, which are acidic, intersect the former in a north-easterly direction.

The ore occurs in veins, bunches or disseminations through a schistose greenstone intermixed with a considerable quantity of quartz, whilst in the lower levels this lode material becomes massive with a foliated structure.

These formations usually indicate their presence at the surface as a ferruginous outcrop the course of which is nearly north and south, in which copper, if present, usually only occurs as stains, whilst in some instances as much as 30 feet has been sunk before ore of any value was met with.

In the oxidised zone the ore usually consists of green and grey ore associated with a considerable quantity of oxide of iron and quartz, which passes almost directly into chalcopyrite and pyrites, there being no marked zone of secondary sulphide enrichment (except along a fracture in the lode), although the last-mentioned class of ore is certainly richer in the upper section of the sulphide zone. This is purely a copper mining district, the gold only occurring in appreciable quantities as the result of concentration in the oxidised zone below which in the solid country containg sulphides there is too little to materially add to the value of the ore.

Although some of the best lodes of this field exist in this locality the returns do not compare as favourably with the others as might be expected; this, however, is easily accounted for by the fact that at the time when the recent rise in the market value of copper took place these mines were practically at a standstill, all available ore having been raised, whilst lower grade mines in other localities had a considerable amount of ore in reserve which previously could not be raised at a profit.

Most of the small mines in this district, like those in the others, are practically at a standstill, owing to the fact that all the high-grade ore in the oxidised zone has been worked out, whilst capital is necessary before further developments can be proceeded with below the water level.

It will be noticed from the following table that only a return of 241 ounces of fine gold is shown from the mines in this locality; this is decidedly incorrect, but may be due to the fact that returns of fine gold values from copper ore were not sent in, or the gold in the ore was not allowed for by the smelters.

Table showing the Yield of the various Mines in the Mt. Desmond District.

Year.	Name and Number of Lease.	Ore treated.	Gold therefrom.	Copper therefrom.
		tons.	ozs.	tons.
1904	British Flag M.L. 174 ..	33.14	18.28	6.05
1904	Diamond M.L. 185	29.39	2.16	6.35
1907	Diamond Central, M.L. 255 ..	3.01	...	0.45
1901–8	Elverdton, M.L. 95	3,787.96	33.00	506.68
1901–4	Elverdton South M.L. 168 ..	37.18	..	7.14
1903	Elverdton Welcome Stranger M.L. 139	5.31	..	0.85
1901–7	Fairlie, M.L. 266	24.98	..	4.91
1903–6	Great Oversight, M.L. 210 ..	107.83	2.55	11.82
1907–8	Ironclad, M.L. 275	15.11	3.64	3.25
1901	Marnoo, M.L. 104	4.25	..	0.88
1901–7	Mt. Desmond, M.L. 109 ..	1,484.78	162.40	173.72
1902–8	Mt. Garrity, M.L. 271 ..	48.71	..	9.65
1904–7	P.L.P., M.L. 199	179.54	10.91	29.00
1906	Resurrection, M.L. 234 ..	1.10	0.06	0.10
1904	Rio Tinto, M.L. 158	6.50	0.32	1.17
1901–7	Thistle and Shamrock, M.L. 257	101.95	8.40	17.54
	Total	5,870.74	241.72	779.56

Average rate of .04 ozs. of fine gold per ton and 13.28% of copper.

Mt. Garrity, M.L. 271.—This lease, which has been held off and on since 1902, is situated at the base of the range, about 2½ miles to the north-west of the Elverdton Mine, and upon it a considerable amount of prospecting has been done upon some small and irregular bodies of ore, but so far no defined lode has been discovered.

The rocks belong to the acidic series and have a marked foliation at the surface, the direction of which is north and south, whilst the ore appears to be associated with the usual basic dyke material and quartz.

Table showing the Yield of the Mt. Garrity Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1902	Mt. Garrity, M.L. 117 ..	12.50	..	26.00
1904	Mt. Garrity, M.L. 173 ..	15.01	..	21.38
1906	Blue Spec, M.L. 238	11.83	..	12.58
1907	Mt. Garrity, M.L. 271 ..	6.93	..	17.31
1908	Do. do.	2.44	..	17.21
	Total	48.71	..	19.81

Average value of ore, £11 per ton.

Great Oversight, M.L. 210.—This lease lies about half a mile to the southward of the Mt. Garrity, and upon it a basic dyke outcrops which is in all probability the northern extension of that exposed in the workings of the Rio Tinto Mine. This dyke is highly weathered at the surface and contains a considerable quantity of biotite which develops into a heavy black mica schist at a little depth below, then passing imperceptibly into foliated massive greenstone.

Upon either side of this dyke, which has a course a little west of north, is a copper vein; that upon the eastern side, which is the smaller of the two, has an underlay to the eastward and is said to have yielded some good ore. It has been sunk on to a depth of about 50 feet, the ore from the upper portion of the lode being in part ferruginous and in part siliceous, but both contained blue and green carbonate of copper, whilst at the bottom it is poor, consisting of a dark schist impregnated with copper pyrites.

The main workings are situated upon the western side of the dyke, where a vein of ore has been sunk on to a depth of 90 feet, in which it is proved to be from 6 feet to 8 feet in width and to underlay to the westward.

About 90 feet farther south another shaft has been sunk to a depth of 60 feet, whilst the lode at the surface has been traced by open cuts for a further distance of 30 feet in this direction.



Photo. H. W. B. Talbot. Neg. 412.

The Ironclad Mine.

In these workings the ore above water level (35 feet) was of the usual ferruginous carbonate of copper type in a siliceous matrix, but below it passed into schistose greenstone and quartz containing copper and iron pyrites disseminated throughout of too low a grade to smelt without concentration.

Table showing the Yield of the Great Oversight Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1903	Great Oversight, M.L. 154 ..	1.14	..	28.07
1904	Do. do. ..	33.41	0.04	15.00
1906	Great Oversight, M.L. 210 ..	42.34	0.02	10.41
1907	Do. do. ..	30.94	..	6.70
	Total	107.83	0.02	11.00

Average value of ore, £8 per ton.

Rio Tinto, M.L. 158.—About two miles to the northward of the Elverdton, and adjoining the Great Oversight on the south, are some old abandoned shafts that were sunk upon a clay flat in the year 1904, when 6½ tons of ore were raised which yielded 18 per cent. of copper.

No lode outcrops in this locality, and the only indication of the presence of ore was some scattered fragments of carbonate of copper upon the surface, which led to prospecting by trenches, in one of which a vein was discovered which measured 3 feet in width, and had a strike of south-east with a dip to the eastward.

The country rock is granite, but the lode, like the others of this district, is a ferro-magnesian dyke in which some rich bunches of green and grey copper ore are said to have been met with below a depth of 20 feet, the upper section being poor, whilst at the bottom of the shaft, which is 40 feet in depth, the lode was driven upon in a northerly direction for a distance of 20 feet in a massive greenstone rock containing splashes of copper and iron pyrites.

Ironclad, M.L. 275.—This lease is the northernmost of the Elverdton group, and upon it is a lode having a north-east and south-south-west course with an almost vertical dip, which is being prospected and will in all probability prove to be of the same character as those in the Elverdton and Mt. Desmond, viz., a cupriferous ferro-magnesian dyke, but in this case since the country rock is basic schists this point cannot be definitely settled until further development has been done.

At the surface the ore body only gave indications of its presence as a ferruginous quartz vein with a few copper stains, and it was not until this had been sunk upon to a depth of 20 feet that any copper ore was encountered, whilst another 10 feet was

sunk before the ore proved to be of a high enough grade to be profitably worked.

At a depth of 60 feet a level has been driven for a distance of 60 feet south upon the lode, which contains a good vein of ore three feet in width for a length of 30 feet from the shaft, beyond which it becomes small.

This vein has been stoped up for some four to five feet above this level, which is the limit to which the good ore extended, but since this is apparently going down strongly under foot, it is possibly the top of a rich ore body. The formation containing this vein is greenstone schist carrying a little copper, but up to the time of inspection it had not been crosscut.

The ore above the water level is a semi-decomposed sulphide with a good deal of carbonate of copper staining, whilst below it it consists of both primary and secondary sulphides, of which 15 tons have been smelted returning 21.59 per cent. of copper.

In these workings the salt water was struck at a vertical depth of 35 feet which makes at the rate of 3,000 gallons in 24 hours.

At a distance of 160 feet south from the main shaft another shaft has been sunk to a depth of 40 feet upon a ferruginous quartz body, the vein of ore in which is about three feet in width and carried carbonates of copper in small quantities from the surface downwards.

To the northward of these workings is a large ironstone outcrop five chains in length, which follows a course north-west and south-east, and shows a section of 30 feet in thickness at a point where it is crossed by a gully. Upon this a shaft has been sunk to a depth of 30 feet, from which a parcel of iron ore (some of which was copper-stained) was sent to the smelters for flux, therefore this is possibly the cap of a copper lode.

Mt. Chester, M.L. 250.—This lease lies to the eastward of the Ironclad, upon the top and upper section of the western face of the Ravensthorpe Range, and within it a large manganese lode outcrops, which can be traced at the surface for a distance of 250 yards, its width at one place where crosscut being 20 feet.

With the object of testing this at a depth an adit level was driven for a distance of 424 feet into the hill face from a point about 90 feet below the outcrop.

This drive passed through a series of kaolinised schistose rocks, some of which are highly ferruginous, whilst from others almost all traces of iron have been removed by leaching; some of these are distinctly gritty to the touch through containing small particles of quartz, whilst others consist of almost pure kaolin.

These rocks have a well-defined lamination which strikes in a north-westerly and south-easterly direction and dips at an angle of from 70 to 75 degrees to the south-west, the whole being traversed by numerous irregular veins and bunches of oxide of iron (leaching channels), whilst strange to state, although one of the large well-

defined ferruginous outcrops (called ironstone lodes) exists at the surface upon the face of the hill between the manganese outcrop and the tunnel mouth, absolutely no sign of this other than the veins before referred to was cut in this drive. At a distance of 300 feet from the entrance the manganese lode was cut, at which point, although consisting of a body 20 feet in width from wall to wall, it is composed of two veins of a more powdery character than the ore at the surface, the largest of which is nine feet in width.

P. L. P., M. L. 199.—This mine is situated immediately to the northward and adjoins the Mt. Desmond, and upon it two distinct lines of lode have been worked, the first or eastern being the same as was prospected close to the northern boundary in that lease.

Upon this three shafts have been sunk, the deepest of which is 75 feet, and from it a level has been driven south at a depth of 65 feet for a distance of 45 feet, at which point the formation, which consists of a basic dyke 12 feet in width, has been crosscut in a westerly direction; this carries a little copper and iron pyrites throughout, whilst the more highly foliated portions at its contact with the granite upon either wall contain a good deal of chalcopyrite and covellite. This level has also been driven upon the other wall for a distance of 20 feet, at which point it connected with the southern shaft.

A few chains to the westward a well-defined dyke outcrops upon the western side of which a small but rich vein of copper ore has been followed down by a shaft to a depth of 74 feet, at which point a crosscut was driven to the eastward for a distance of six feet in formation carrying a little copper pyrites, but work was discontinued before the other wall was cut. Upon the eastern side of this dyke a little to the northward of this shaft another small vein of copper ore has been worked from an opencut and some shallow shafts.

Table showing the Yield of the P.L.P. Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1904	P.L.P., M.L. 199	7.43	0.10	14.00
1905	Do. do.	45.23	0.10	18.00
1906	Do. do.	58.19	0.03	19.43
1907	Do. do.	68.69	0.05	12.37
	Total	179.54	0.06	17.00

Average value of ore, £11 4s. per ton.

Mt. Desmond Copper Mine, M.L. 109 (Plate V.).—In this mine, which lies to the north-eastward of the Elverdton, the lode is

of a similar character to that worked in that mine, viz. : a foliated cupriferous basic dyke ; it is considerably larger in size, but so far has not proved to carry ore in such a concentrated form, with the exception of a length of 100 feet in the upper levels.

The course followed by this lode formation is generally north and south, with an underlay to the eastward, and this has now been driven upon at the 96 feet level for a length of 480 feet at the southern end, of which it strikes one of the main north-westerly dykes, the outcrop of which is plainly visible at the surface (see map).

Upon the south side of this dyke, a lode following the same course as that first mentioned has been prospected upon the Desmond and British Flag leases, and this is in all probability the continuation of the same fissure, but the exact relationship in which these two stand to one another cannot as yet be determined.

The Mt. Desmond lode was traced at the surface for a distance of 300 feet, the southern end of which, near the greenstone dyke, is highly siliceous, but about 200 feet farther north the cap of a rich ore body, 25 feet in length, was cut, which was of a highly ferruginous character, containing nice bunches of carbonate of copper.

This rich portion of the lode was worked to the 45 feet level, where it lengthened out to 125 feet, having throughout an average width of from 4 to 5 feet, whilst from the stopes above, the original owners obtained 230 tons of 13½ per cent. ore.

When this property was acquired by the Phillips River Gold and Copper Company, a vertical shaft was sunk to a depth of 250 feet at a point 250 feet north of the old workings, and from this the 96 feet level has been driven 350 feet south and 125 feet north, the ore body being cut 145 feet south of the shaft. Here it consisted of two sections of payable ore, containing chalcopyrite, corvellite, and pyrites, which have been stoped up to the 40 feet level, the first portion of which is 60 feet in length, when after ten feet of low grade material, the second is 30 feet in length.

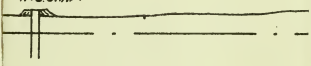
The formation in this level is of considerable width, varying from 20 feet at the south end, up to 60 feet at the north, and consists, generally speaking, of a low grade, dark cupriferous greenstone, often schistose, and particularly so near its contact with the granite, which encloses it.

At the 196 feet, a level has been driven for a distance of 170 feet south, at which point it is connected with the 96 feet level by a winze, in which the downwards continuation of the rich vein worked in the upper levels is exposed, it being where passed through a body of high grade chalcopyrite of greater width than the winze.

From the stopes above, the 96 feet level and the winze below it, the present company has raised 1,256 tons of 11½ per cent. ore.

DE

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Minister for Mines.

PLAN & SECTION OF
THE Mt DESMOND MINE

MINERAL LEASE 109
KUNDIP
PHILLIPS RIVER C.F.

0 80 160 240 320
Scale of Feet.

Stoped

M.L
109
Mt DESMOND

N. 27° 18' W.

No 4 N. SHAFT
40 FT L.
No 5 N. SHAFT
X CUT E.
No 3 N. SHAFT
No 2 N. SHAFT
96 FT L.
No 1 N. SHAFT
96 FT L.
No 1 N. DRIVE
No 1 X CUT E.
No 2 X CUT E.
No 3 X CUT E.
No 4 X CUT E.
No 5 X CUT E.
No 6 X CUT E.
MAIN SHAFT
196 FT L.
No 1 S. SHAFT
No 2 S. SHAFT
No 3 S. SHAFT
No 4 S. SHAFT
No 5 S. SHAFT
No 6 S. SHAFT

LONGITUDINAL SECTION

M.L.
208
DESMOND

Datum Level
No 5 SHAFT
No 4 SHAFT
No 3 SHAFT
No 2 SHAFT
No 1 SHAFT
MAIN SHAFT
No 1 S. SHAFT
No 2 SHAFT
No 3 SHAFT
No 4 SHAFT
No 5 SHAFT
No 6 SHAFT
S. DRIVE 80' L
X CUT E.
X CUT W.
47' L
96' L
196' L
No 1 N. DRIVE
No 1 S. DRIVE
No 1 X CUT E.
No 2 X CUT E.
No 3 X CUT E.
No 4 X CUT E.
No 5 X CUT E.
No 6 X CUT E.

A Gibb Maitland
Government Geologist.

TAKEN FROM MINE PLANS 30. 6. 08.

C B Kidson. del.

H J Pether, Government Lithographer, Perth W.A.

Owing to the fact that the water was up the mine, the bottom level could not be inspected, but to judge from the stone upon the dump, the lode consisted of a low grade pyritic and cupriferous massive greenstone, whilst from information furnished by the plan the formation would appear to be of even greater size in this than the level above.

Close to the northern boundary of this lease, the southern extension of the P.L.P. lode has been tested in this lease by a shaft 100 feet in depth and a crosscut east, in which the dyke body proved to be 30 feet in width and to consist of a massive cupriferous, greenstone body, which was driven upon in a southerly direction for a distance of 90 feet.

These workings were not inspected, but to judge from the stone at grass it is a low grade sulphide body, requiring concentration before smelting.

Table showing the Yield of the Mt. Desmond Copper Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Mt. Desmond, M.L. 109 ..	23.00	0.06	6.30
1903	Do. do. ..	35.47	..	15.20
1904	Do. do. ..	64.35	0.22	15.00
1905	Do. do. ..	76.05	0.30	14.00
1906	Mt. Desmond, Phillips River Gold and Copper Co., Ltd. M.L. 109	484.72	0.13	12.42
1907	Mt. Desmond, Phillips River Gold and Copper Co., Ltd., M.L. 109	801.19	0.07	10.32
	Total	1,484.78	0.11	11.70

Average value of ore, £11 per ton.

Elverdton Copper Mine, M.L. 95 (Plate VI.).—This mine, which is situated close to the western side of the Ravensthorpe Range, upon a ridge that forms the water parting between the basins of the Steere and the Jerdacartup Rivers, proved in its earliest stages to be of exceptional richness, so much so, in fact, that it was purchased from the original discoverers by the Phillips River Options Syndicate N.L., entirely out of the proceeds of the sale of ore raised during the short period over which they held the right of purchase. Subsequently, this Syndicate also acquired, equipped, and developed several other properties solely out of profits made in this mine, but unfortunately in so doing they neglected the only one of value, and in consequence, when the oxodised ore had been rooted out down to the water level, no funds were available for the purchase of plant, or for further development.

This property was then purchased by the Phillips River Gold and Copper Company, who have now developed a fine ore body down to the 350 feet level. The workings in this mine may be divided into two groups, viz. : the shallow and the deep, the former of which were carried out by the old syndicate and are confined practically to the oxidised zone, whilst the latter by the present Company are entirely below the ground water level in the sulphide zone.

In the upper workings, which extend for a length of 680 feet (including those upon the South Elverdton, M.L. 168), the lode may be said to contain three bonanzas, the northern or principal one, which was 180 feet in length, and averaged about 6 feet in width, has been stoped out bodily to a depth of 87 feet, the ore being a high grade ferruginous carbonate of copper, siliceous in part. The second or middle, which lies to the southward of a fault, which crosses the lode, did not outcrop, but was worked up from the 42 feet level to within 8 feet of the surface for a length of from 70 to 110 feet, whilst the third or southern patch, which is in the South Elverdton lease, was worked above the 40 feet level, when the ore consisted of nodules of green carbonate of copper, contained in a kaolin matrix.

From these workings upon the Elverdton proper, 3,054 tons of 15 per cent. ore were raised and from the South Elverdton 37 tons of 19 per cent. ore, but in spite of the fact that in the early days of this mine, the ore in the oxidised zone carried as much as 6dwts. of gold per ton; no returns appeared until quite recently.

Immediately below the 87 feet level, the lode consists of a siliceous schistose greenstone, through which copper and iron pyrites are disseminated, but it also contained two lenticular bunches of ore of higher grade (chalcopyrite, with covellite coatings), which were stoped up from the 130 feet to the 87 feet level, one of which was 60 feet in length and the other 20 feet.

At the 130 feet level, which has been driven for a distance of 200 feet north of the main shaft and 45 feet south, the lode was very siliceous and carried low values.

The main shaft was then carried down to the 250 feet level and a crosscut driven east 15 feet, where it cut the ore body which here consists of a foliated greenstone, containing quartz chalcopyrite and pyrites in bands. This was driven upon in a northerly direction for a distance of 30 feet, when all signs of ore were lost, however what was supposed to be the line of fissure was followed for a distance of 100 feet, but since no ore was met with, a bore hole was put in for a distance of 15 feet to the eastward, which proved the existence of a fine body of chalcopyrite in that direction. A crosscut was then driven and the lode followed back in the direction of the main shaft to the point where it was originally lost, where it was discovered that a pinch had taken place. This level was then con-

TINE

PLAN & SECTION
OF
THE ELVERDTON MINE
MINERAL LEASE 95
KUNDIP
PHILLIPS RIVER G.F.

0 100 200 300
Scale 1 Foot

Stoped

M.L. 95
ELVERDTON

MAIN SHAFT

SOUTH ELVERDTON

LONGITUDINAL SECTION

MAIN SHAFT

TAKEN FROM MINE PLANS, 3 3 08

C.S. Hudson del.

H. J. Pether, Government Lithographer, Perth, W.A.

tinued for a distance of 200 feet farther north, the last 60 feet of which was in very low grade ore, whilst the balance of 270 feet averaged about 3 feet in width of 9 per cent. ore.

From this level at a point 190 feet north of the main shaft, a rise has been put up 60 feet in which the ore vein averaged 4 feet in width, worth 13 per cent. of copper.

Close to the main shaft a fault is exposed, which has apparently deflected the course of the lode to the south-eastward for a distance of 90 feet, after which it falls back upon its original strike, which has been further driven on for 150 feet. In this section of this level the ore values are for the most part low, with the exception of one point, where along a line of fracture a considerable amount of secondary sulphide enrichment has apparently taken place.

At the 350 feet level, the lode has been driven upon in a northerly direction for a distance of 300 feet, in which the ore body averages about 4 feet in width, and has a value of about 5 per cent. of copper per ton, thus showing an increased length and width, but a decreased value from the level above, the latter being probably due to the fact that less secondary enrichment has taken place and therefore this may be taken to represent more nearly the permanent value.

At a point 100 feet north of the main shaft, a rise has been put up to the 250 feet level in which the vein of ore averaged 2 feet 6 inches in width and assayed 9 per cent. Although the gold values carried in the upper workings are not recorded, they are stated to have been about 6dwts. per ton; these decreased to 3dwts. at the 250 feet level and 2dwts. at the 350 feet level, thus clearly demonstrating that the occurrence of this metal in appreciable quantities was due to secondary enrichment, and, therefore, the future value of this lode will probably consist of copper only. The general course of the lode is north and south, with a dip to the eastward of about 80 degrees; it is a cupriferous dyke, occurring in lenticular masses in a granitic country, the richest portions having so far been met with upon the footwall or western contact.

This dyke does not give any indication of its presence at the surface, whilst in the upper levels it is too highly decomposed to determine its character; below the water level, however, it assumes the appearance of a schistose greenstone, containing large quantities of quartz, whilst in the deeper workings it becomes massive.

The ore in the upper workings was the usual ferruginous carbonate of copper, associated with a considerable quantity of quartz, whilst below the water level it changes directly into chalcopyrite and pyrite in a foliated greenstone matrix with some quartz, the only indication of secondary sulphide enrichment being along cross fracture zones, where incrustations of covellite often occur upon the yellow ore.

Table showing the Yield of the Elverdton Copper Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Elverdton, M.L. 95	557.00	..	28.40
1903	Elverdton, Phillips River Options Syndicate, N.L., M.L. 95 ..	527.88	..	12.05
1904	Elverdton, Phillips River Options Syndicate, N.L., M.L. 95 ..	1,223.72	..	12.42
1905	Elverdton, Phillips River Options Syndicate, N.L., M.L. 95 ..	443 42	0.01	13.85
1906	Elverdton, Phillips River Options Syndicate, N.L., M.L. 95 ..	172.40	..	10.81
1907	Elverdton, Phillips River Options Syndicate, N.L. M.L. 95 ..	130.00	..	4.38
1907	Elverdton, Phillips River Gold and Copper Co., Ltd., M.L. 95	541.97	0.02	5.76
To June, 1908	Elverdton, Phillips River Gold and Copper Co., Ltd., M.L. 95	191.56	..	8.24
	Total	3,787·96	..	13·32

Average value of ore, £8 per ton.

Thistle and Shamrock, M.L. 257.—This lease, which has previously been known as the Welcome Stranger, C.D.C., and Addie, is situated at a short distance to the south-eastward of Elverdton, and upon it a lode which strikes in a north and south direction with a vertical dip, has been sunk upon to a depth of 80 feet (water level). It is from 2 to 3 feet in width, and lies between a greenstone dyke upon the west and granite country upon the east, and in it no payable ore was cut until a depth of 20 feet was reached, when a vein of from 6 inches to 1 foot 6 inches of high class carbonates was encountered, which was followed down. About 60 feet further north, a shaft has been sunk to a depth of 74 feet, at which level the lode has been driven on for a length of 80 feet, connecting with the first mentioned shaft.

The ore is of the usual ferruginous oxi-carbonate of copper siliceous in part, whilst at the bottom of the main shaft the sulphides begin to make their appearance.

Table showing the Yield of the Thistle and the Shamrock Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Welcome Stranger, M.L. 87 ..	4.00	..	22.00
1903	Welcome Stranger, M.L. 167	9.85	..	15.00
1904	Do. do. ..	2.92	0.24	12.00
1904	C.D.C., M.L. 186	18.43	0.17	13.67
1905	Do. do.	18.07	0.03	17.32
1906	Addie, M.L. 232	5.13	..	19.68
1907	Thistle and Shamrock, M.L. 257	34.75	0.02	17.44
To June, 1908	Do. do. ..	8.80	0.34	24
	Total	101.95	0.08	17.20

Average value of ore, £10 12s. 6d.

Fairlie, M.L. 266.—This property, which has been worked off and on since 1901, under the names of Mountain View, O.K., and Fairlie, lies higher up the range to the eastward of the last mentioned.

There are two cupriferous greenstone dykes enclosed in granitic country upon this lease, the western of which has a north and south course and can be traced for a length of 100 feet at the surface. The ore is of a high quality and occurs in a vein about 1 foot 6 inches in width, which has been sunk on to a depth of 75 feet and driven upon north and south for a distance of 80 feet, whilst all the ore has been stoped up from the 60 feet level.

Upon the eastern lode the north shaft has been sunk to a depth of 52 feet with a drive 27 feet, in which the cupriferous greenstone dyke has been crosscut, proving to be 13 feet in width, with upon the eastern wall a vein 2 feet 6 inches thick of ferruginous material, containing bunches of carbonate of copper.

Table showing the Yield of the Fairlie Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Mountain View, M.L. 107 ..	9.50	..	28.84
1905	O.K., M.L. 188	6.67	..	15.00
1906	Fairlie, M.L. 266	0.84	..	15.48
1907	Do. do.	7.97	..	13.00
	Total	24.98	..	19.66

Average value of ore per ton £14.

THE KUNDIP CENTRE.

This group of leases is situated to the northward of the township of Kundip, which is about 20 miles from Hopetoun and 12 miles from Ravensthorpe. It is the southern extension of the Mt. Desmond belt, which follows the Steere Valley upon the south-western face of the Ravensthorpe Range; this particular section being about one mile in width and three miles in length.

The rocks forming this belt are for the most part schistose greenstone, leached and kaolinised in part, but at the north end, upon the Mt. Stennett lease, massive greenstones form the country, whilst upon the western side of the Steere River, schistose granite is met with upon the Ard Patrick lease.

The directions of the lodes vary considerably, but may be divided roughly into two groups; the first of these, which has a more or less north and south strike, following the foliation of the rocks, dips to the eastward, and may be called normal lodes, whilst the second, which has a more or less east and west course, coincides with

the jointing planes dipping to the southward, and they may be called cross lodes.

Of these, both the normal and the cross series of lodes carry both gold and copper in the greenstone area, whilst the siliceous lodes in the granitic or kaolinised area are for the most part aurifrous only.

From the surface downwards to a depth of from 10 to 40 feet these lodes are almost destitute of copper, but below this to the water level (which varies with the elevation of the surface), carbonates and oxides are met with in the form of pipe-like zones, which in the normal lodes are inclined upon the fissure plane to the south, and in the cross fissures to the eastward.

In this latter class of fissures the copper ore appears to be richest along those lines at which the lode channel has intersected rocks of a more highly basic character, and in consequence the inclination of these zones is usually coincident with the foliation planes, upon which spur veins occasionally strike off.

Near the water level the sulphides make their appearance; the chalcopyrite when in a semi-decomposed condition being often coated with covellite, which is the only indication of secondary sulphides enrichment.

The lode matter generally appears to consist of a weathered basic intrusive rock, highly ferruginous and siliceous in part, which becomes pyritic below the water level, and this as a rule carries gold in greater or less quantities, also traces of copper; since, however, little work has been carried on as yet in the sulphide zone, the precise character of the ore has not been determined.

The siliceous gold lodes in the acidic and kaolin series as a rule dip at a low angle to the south, they do not all outcrop at the surface, but occur in a more or less tabular form, sometimes as sheets of ferruginous quartz, but more often as a network of veins in a kaolin matrix.

The majority of lodes of this district have so far proved to be cupriferous gold veins, but are apparently changing at the water level into auriferous copper lodes, whilst in all probability in the primary sulphide zone the gold values will fall even still lower.

Up to the present time most of the ore has been hand-sorted for smelting purposes, the balance being treated in the batteries for gold by which process an extraction of from 40 to 50 per cent. only is obtained, whilst the rich sands containing half the gold contents are too cupriferous to be amenable to cyanide extraction. These remarks do not apply to the ferruginous quartz veins which carry only gold, in which case if extraction is low it is solely due to faulty plant or management.

Upon the whole this district is a promising one, but lodes are valueless without capital to carry out the initial development and equipment, and since most of the payable ore has been scratched out from above the water level, the prospect is not too encouraging.

The following table gives the tonnage of ore treated either by smelting or battery, with the gold and copper returns therefrom from each productive lease in this district, whilst further details will be found accompanying the descriptions of the individual mines:—

Table showing the Yield of the various Mines in the Kundip District.

Year.	Name and Number of Lease.	Ore treated.	Gold therefrom.	Copper therefrom.
		tons.	ozs.	tons.
1906	Afric, G.L. 197	6.02	..	0.78
1907–8	Alice, G.L. 143	53.50	14.83	..
1906–7	Alice Mary, G.L. 99	28.02	3.83	0.96
1906–8	Ard Patrick, G.L. 107 ..	180.00	184.57	..
1902–7	Australia, M.L. 242	29.40	0.62	4.60
1906–8	Charmion, G.L. 132	47.50	28.81	..
1904–8	Christmas Gift, M.L. 184 ..	871.13	400.90	13.41
1901–8	Flag, G.L. 136–9	2,668.49	1,886.17	61.79
1908	Finnis, G.L. 126	0.05	19.77	..
1903–8	Gem, G.L. 65	2,648.85	1,330–44	..
1903–4	Gladstone Prop., G.L. 69 ..	..	91.12	..
1908	Great Britain, G.L. 294 ..	13.00	5.93	..
1900–8	Harbour View, M.L. 52 ..	6,155.08	2,513.00	131.69
1907–8	Harbour View North, G.L. 81	114.92	59.10	0.30
1904–7	Hecla, M.L. 206	28.86	..	3.55
1906–8	Hillsborough, G.L. 98 ..	413.80	516.31	3.84
1906–7	Kundip, G.L. 133	211.00	64.56	..
1906–7	Lily, G.L. 104	330.00	115.76	..
1904–8	Medic, G.L. 66	677.46	597.98	..
1902	Minna, G.L. 42	161.00	94.92	..
1904–8	Mosaic, M.L. 291	72.25	21.73	8.01
1901–7	Mt. Stennett, M.L. 108 ..	298.97	24.68	41.62
1902–7	Omaha, G.L. 73	344.94	369.72	1.37
1908	Queen of the Earth, G.L. 129	..	63.00	..
1907–8	Stowaway, G.L. 106	14.00	55.20	..
1906	Thrice Call, G.L. 114	8.75	10.10	..
1904–8	Two Boys, G.L. 74	1,142.12	1,568.77	..
1906	Try Again, G.L. 120	9.50	7.10	..
1906–8	Western Gem, G.L. 80 ..	138.17	105.54	..
	Total	16,666·78	10,154·46	271·92

Average value of the ore treated, 0.61 ozs. of fine gold per ton and 1·62 % of copper.

Mount Stennett, M.L. 108.—At the extreme north end of the section of this mineral belt is an old copper mine known as the Mt. Stennett, called after the prospector and owner. It is situated about three miles north of Kundip at the base of the Ravensthorpe Range, and upon the eastern bank of the Steere River. The country at this point consists of a massive greenstone, probably a quartz diorite, which has broken into the foliated series composing the range.

The lode which is situated close to the southern boundary of the lease, has a nearly north and south course with a dip of one in four

to the eastward, whilst the greenstone in the immediate proximity to it is of a schistose character. It has been opened up by three underlay shafts from which it has been proved for a length of 110 feet. The central of these shafts is called the Whip shaft, and has been sunk upon the dip of the lode to a depth of 140 feet, the ground water being met with at a depth of 120 feet.

Immediately above this the lode has been driven upon in a southerly direction for a distance of 60 feet, whilst the patches of the richest ore from above this drive have been stoped to the surface The total width of the ore body at this level has not as yet been tested by crosscutting it from wall to wall. At a depth of 80 feet a level has been driven north for a distance of 30 feet, whilst from between it and the surface most of the ore has been stoped. These stopes are connected with the northern underlay shaft which is 45 feet in depth.

The average width of the lode in these workings was 3 feet 6 inches, the sulphides coming in at a depth of 80 feet, above which the ore consists of blue and green carbonate with oxides of copper, which was often highly ferruginous and always siliceous.

The southern shaft, which is 27 yards south of the whip shaft, has been sunk to a depth of 65 feet, from the bottom of which a level has been driven upon the lode for a distance of 30 feet north from above which the stone has been stoped for a height of 20 feet.

From this shaft at a depth of 25 feet, the lode has been driven on in a northerly direction for a distance of 30 feet, at which point the veins of ore which had varied from 12 to 30 inches petered out. The whole of the ore from above this level has been stoped out. South from this shaft, also at this level, the lode has been driven on for a distance of 12 feet, but in it the vein was too small to be payable.

The richest ore, which has averaged 13.6 per cent., appeared to occur in two pipe-like shoots, from which 298.87 tons have been raised, which represents practically all the ore of any value above the water level, since the balance still in sight is of too low grade to pay to raise by itself.

This mine has therefore been worked to a standstill, and will need capital to be expended upon further developments before any estimate as to the value of the lode in the sulphide zone can be formed.

About 10 chains north of the main group of workings another shaft has been sunk upon the underlay of a vein in the solid greenstone area to a depth of 95 feet (water level), and from the bottom of it a level has been driven 20 feet south, whilst another has been driven 12 feet in the same direction at a depth of 70 feet.

This lode is mostly ferruginous, with a little carbonate of copper to a depth of 30 feet, below which traces of sulphides make their appearance, the picked ore from which contains about 14 per cent. of copper and 10 dwts. of gold.

Table showing the Yield of the Mt. Stennet Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Mt. Stennett, M.L. 108 ..	32.00	0.12	19.00
1903	Do. do.	100.10	..	15.42
1904	Do. do.	65.56	0.29	13.21
1906	Do. do.	47.02	..	10.00
1907	Do. do.	54.29	0.03	12.58
	Total	298.97	0.08	13.92

This ore has realised on the average £9 5s. per ton.

Ard Patrick, G.M.L. 107.—This quartz reef has a strike north-east and south-west, and dips at an angle of about 45 degrees to the south-east, outcropping for a distance of four chains. At its eastern end it terminates suddenly upon coming in contact with a greenstone dyke; 36 feet northward of this point, however, a vein of quartz is seen outcropping which can be traced at the surface for a distance of one chain in a north-easterly direction, which is possibly the dislocated continuation of the same lode.

At the west end of this line an underlay shaft has been sunk to a depth of 30 feet, the stone in which averages about 2 feet 6 inches in width, and is said to be worth about 30dwts. At a point 34 yards farther east the reef has been sunk upon to a depth of 16 feet, where it varies from 1 foot 6 inches to 2 feet in width, and is said to be worth 8dwts., whilst nine yards still farther east there is a small pothole in which the vein is again exposed. A 30 feet vertical shaft, which cut the reef at that depth, has been sunk 29 yards farther east, but little work was done at this point owing to the fact that the reef pinched to a small size and was of little value. North of this 11 yards is the main underlay shaft, which has followed a good shoot of stone down from the surface for a distance of 110 feet, when it connects with the 60 feet level driven from the main vertical shaft which is situated 48 feet west.

This main shaft struck a heavy supply of salt water at a depth of 30 feet, but was continued down to a total depth of 70 feet. This water was at first difficult to handle, but after continuous bailing it has now been reduced to 3,000 gallons in the 24 hours.

Most of the reef above the 60 feet level in the underlay shaft has been stoped for a length of 55 feet, its average width being 2ft. 6in. Above this level the quartz is of a laminated character, and mostly white, being enclosed between two fairly well-defined walls of decomposed granite; the whole, however, is cut off at the eastern end by a weathered foliated greenstone dyke, upon the wall of which the stone makes a turn to the south-east, whilst at the west end of this level the vein pinches and becomes poor.

Below this level a sheet-like intrusion of greenstone (now weathered) makes its appearance, following the foot-wall of the lode, the surface of which is highly polished. At this level and also upon the foot-wall side of the reef some small veins of ferruginous manganese junction with the lode, which below this point become iron-stained and manganese-coated in places.

At the bottom level, which is 60 feet in vertical depth and 110 feet upon the underlay, the lode varies from 2 feet 6 inches to 3 feet in width, and presents a fairly solid appearance with a particularly well-defined foot-wall. In this level the shoot is about the same length as in the level above, and like it is cut off by the cross course at the east end and pinches in a similar manner at the west end. This block between the two levels is now being stoped.

About 36 feet north of the terminal point of outcrop of this reef at its eastern end where it is cut off by the greenstone bar, and upon the other side of the latter, a quartz vein of similar character has been opened up by a 30 feet underlay shaft with a drive at the bottom 15 feet east, in which the stone is 2 feet wide and is estimated to be worth 10dwts. The outcrop of this vein has been traced for the further distance of one chain east in a series of pot-holes.

This last-mentioned reef is in all probability the dislocated continuation of that first mentioned, it having been thrown off its course by faulting along the dyke fissure, since there is no indication at the surface of any other vein upon the opposite side of it; below ground, however, the indications point to the throw being in the other direction, therefore this question can only be satisfactorily settled by crosscutting the dyke and driving upon its eastern side.

The stone raised is carted a distance of about two miles to a battery where it is crushed, but since there are no means for sands treatment the 7dwts. contained in the tailings are lost, which is a serious matter to the owners.

Up to the end of June, 1908, this mine has produced 180 tons of quartz, which has yielded 184.57ozs. of fine gold, which is at the rate of 1.02ozs. per ton, whilst if the 7dwts. lost in the tailings are added this brings the total value of the stone up to 1.37ozs. to the ton.

Table showing the Yield of the Ard Patrick Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1906	Ard Patrick, G.L. 107 ..	10.00	14.48	1.44
1907	Do. do. ..	121.50	117.41	0.97
Up to June, 1908	Do. do.	48.50	52.68	1.08
	Total	180.00	184.57	1.02

Third Call, G.M.L. 114.—This lease is situated upon the eastern or opposite bank of the Steere River to the Ard Patrick. A small ferruginous reef outcrops upon the face of a steep hill, which was sunk upon to a depth of 20 feet, whilst later on an adit level was driven lower down the hill connecting with the shaft bottom. From this in the year 1906, 8.75 tons of stone were raised, which yielded 10.10ozs. of fine gold by battery treatment.

Gladys, M.L. 159.—This mine is situated in the foliated greenstone area at the base of the Ravensthorpe Range two miles north of Kundip upon the eastern banks of the Steere River.

It was originally worked for copper, when some fairly high-grade ore occurring in bunches was discovered at the surface.

Two underlay shafts have been sunk to a depth of 30 feet upon the lode, which was from three to four feet in width, striking north-west and south-east and dipping to the south-west, the ore in which occurred in bunches of carbonate of copper with some glance.

Later on this area was again taken up as a gold lease, when a vertical shaft was sunk a little to the south-west of the old workings to a depth of 70 feet, and from this a crosscut was driven north-east, in which a small quartz reef was met with carrying a little gold and also a small copper vein, but neither of these was large enough to be payable.

Alice Mary, G.M.L. 99.—This lease lies upon the east side of the Christmas Gift, and nearly at the top of the spur; the lode strikes a little south of west and underlays to the southward at an angle of about 60 degrees in blocky greenstone schist.

An underlay shaft has been sunk to a depth of 100 feet, at the bottom of which a short level has been driven to the eastward, in which a small vein of ore is visible.

At its outcrop the lode appears as a ferruginous quartz, no sign of copper making its appearance in the first 10 feet from the surface, but at this point small veins of rich copper ore contained in a mullocky formation about 6 feet in width were encountered. These veins extended in an east and west direction for a length of 30 feet along the lode and downward for 20 feet. At a depth of 60 feet in the shaft another make of ore was cut upon the hanging-wall of the formation, which was from six to eight inches in thickness and 12 feet in length and continued down to the bottom of the shaft 40 feet. In this vein at a depth of 70 feet the ore passed from carbonates into olivenite and erythrite, of which some very pretty specimens were obtained. The vein is small but of high grade, and little prospecting has yet been done upon the lode.

Upon this lease several other small holes have been put down upon ferruginous outcrops, some of which have yielded good prospects for gold at the surface, but so far in no single instance have they carried values down.

From this lease 8.02 tons of ore yielded .96 tons of copper and .52 ounces of fine gold, and 20 tons crushed yielded 3.31 ounces of gold, the total value of which was £101.

Christmas Gift, M.L. 184.—This mine is situated in the foliated greenstone upon a spur of the Ravensthorpe Range, on the east side of the Steere River, about two miles north of the township of Kundip.

Upon this lease the outcrop of a ferruginous lode can be traced at the surface for a considerable distance, the cap of which gives good prospects for gold in places. It has a strike of nearly north and south with an underlay at a high angle to the eastward; it exhibits no signs of copper at the surface, the first indications of which were met with at a depth of 8 feet to 10 feet, but no ore of value was discovered until a depth of 20 feet was reached.

The lode is apparently a greenstone dyke of considerable width, between which and the country the richest copper ore occurs upon either wall, whilst the entire mass (the nature of which cannot be determined owing to its highly weathered character) contains small quantities, and also gold.

A considerable amount of development has been done upon it, a main shaft having been sunk to a depth of 100 feet, which is vertical for the first 40 feet, below which it follows the foot-wall of the formation upon the incline.

At the bottom of this shaft a crosscut has been driven a distance of 18 feet to the hanging-wall of the lode, there being a vein of copper ore upon either wall, whilst the intervening portion is composed of blocky weathered greenstone.

The hanging-wall vein has been driven on for a distance of 20 feet south, at which point the ore pinches out upon a hard bar, but the fissure has every indication of continuity.

In sinking the main shaft a very nice bunch of high-grade ore was cut upon the foot-wall at a depth of 70 feet.

At a depth of 50 feet the formation has been crosscut, at which point it measures 12 feet from wall to wall. In this a nice vein of ore was cut which was driven on in a northerly direction to the north shaft for a distance of 105 feet. In this level the richest ore occurred in zones the length of which near the main shaft was 40 feet, an average width of 4 feet of this has been stoped up for 30 feet.

South of the main shaft the level has been extended for a distance of 90 feet to the south shaft in which the vein is small and poor in the first section but further on opens out to an average size of 4 feet for a length of 40 feet, the ore being mostly stoped out to a height of 30 feet and at one point to the surface.

The formation has as yet only been crosscut at two points, viz., from the main shaft at the two levels, therefore its average size and character cannot be determined. The ore so far as proved, with the exception of the bunch cut upon the footwall at 70 feet in the main shaft, is confined to the hanging wall of the formation, but it is possible that prospecting will prove the existence of other veins or bunches upon the other side.

The footwall where exposed in the shaft is well defined, whilst the hanging wall with the exception of one or two places is of a more ragged character.

The copper ore, which consists of carbonates and oxides of copper associated with ferruginous gossan and quartz, carries gold in greater or less quantities, it being occasionally visible in the stone but the higher average values are usually contained in those portions of the vein which are not so rich in copper and are most highly siliceous, which stone is sent direct to the battery.

There appears to be a large body of low-grade ore in this mine which should pay well to crush and concentrate if facilities were upon the ground, but which under present conditions will not pay. Water has not yet been struck in this mine owing to its elevated position, but it is probable that it will be encountered in sinking in the course of another 50 feet when the sulphide ores will be met with.

Table showing the Yield of the Christmas Gift Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom
		tons.	ozs.	%
1904	Christmas Gift, M.L. 184	217.00	0.67	..
		12.16	..	18.99
1905	Do. do.	62.00	0.75	..
		15.81	..	12.01
1906	Do. do.	1.43	0.87	15.38
1907	Do. do.	287.00	0.43	..
		39.60	..	13.40
To June 1908	Do. do.	212.00	0.25	..
		24.13	0.67	15.25
	Total	871.13	0.47	1.54

Average value of ore received, £3 per ton.

Australia, M.L. 149.—This old abandoned lease is situated upon the western bank of the Steere River about 1½ miles north of Kundip. It has been held later under the name of the Lone Star, M.L. 242 but is better known under its original designation.

The lode strikes north-east and south-west with a dip of 1 in 2 to the south-east, and upon it an underlay shaft has been sunk to a depth of about 50 feet (water level). In this shaft the vein consists of ferruginous quartz with carbonate of copper and is said to average from 2ft. to 2ft. 6in. in width, the picked ore going up to 33 per cent., whilst the length of the vein was 25 feet.

Another shaft has been sunk to a vertical depth of 50ft. with the object of cutting the lode but in it only some small veins of ore are said to have been met with.

Table showing the Yield of the Australia or Lone Star Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1902	Australia, M.L. 149	4.50	..	22.22
1903	Do. do.	3.29	..	20.06
1904	Do. do. ..	8.69	0.06	21.17
1906	Lone Star, M.L. 242	3.90	0.03	10.77
1907	Do. do.	9.02	..	7.54
	Total	29.40	..	15.64

The ore realised on the average £9 per ton.

Gem, G.M.L. 65.—Upon this lease which lies immediately to the northward of the Two Boys, a portion of the same flat reef has been worked, whilst below it another parallel vein or more correctly speaking a series of small veins contained in a belt of decomposed rock was more recently discovered.

This body strikes in an east and west direction and has been followed down from the surface upon an angle of about 40 degrees for a distance of about 200 feet in a southerly direction.

At and near the surface this formation carried no values, whilst downwards for a distance of 70 feet it was poor, but at this depth it was intersected by a small ferruginous quartz vein which apparently has influenced the deposition of gold, for below it the values at once improve.

At the 80ft. level, in which the formation averages 4 feet in thickness, it was found to be payable for a length of 110 feet or from the main underlay shaft in an easterly direction to a point where it is suddenly cut off by a fault having a course north-north-east. Upon this fault a ferruginous body of stone was encountered dipping to the eastward at a high angle, which carries good values and is particularly rich at certain points where the lode material consists of dark coloured loose ferruginous sand.

This vein had been driven on for a distance of 20 feet in a northerly direction and was showing as a strong body in the face which yielded good prospects, whilst to the southward it appeared to split into two small veins.

The 80ft. level has also been driven in a westerly direction from the main shaft for a distance of 30 feet, but in this portion of the mine the formation did not carry high enough values to be payable. The next level is at 140ft. upon the underlay and has been driven in good stone for a distance of 70 feet east to the fault and 30 feet west, of which latter distance the first 15 feet only of the reef carried payable values.

From this level a winze has been sunk midway between the shaft and the fault in a south-easterly direction but was stopped by a dislocation of the country. In this winze a good section of the formation was visible, which here apparently consists of one small main ferruginous vein crossed at an angle by a series of small quartz stringers, the bulk of the mass being composed of highly kaolinized and leached schists, the footwall country being as a rule almost pure kaolin whilst the hanging wall, although similar, is of a more siliceous and gritty character. The main fissure shows signs of the passage of water which has in places deposited secondary silica in a tuffaceous form similar to that met with around hot springs.

At the bottom of the winze the fault has been penetrated for a few feet upon the other side of which no continuation of the vein was met with, whilst the rock although still an altered schist was not nearly so highly kaolinized as that upon the western side. This apparently indicates a drop of the formation lying to the west of this line of dislocation, and if this is the case it would be necessary to rise upon the eastern side in order to pick up the vein.

The main underlay shaft has been carried down from this level for a further depth of 60 feet upon the incline in which the formation presents a well-defined appearance and yields good prospects.

Upon the range to the eastward of these workings there are a series of banded jaspery quartzite, a portion of one of which is covered by this lease, and upon it a considerable amount of prospecting has been done at the surface, whilst lower down the hill a series of extensive adit levels have been driven into it upon white quartz veins in kaolin rock, but so far no payable values have been met with.

Table showing the Yield of the Gem Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1903	Gem, G.L. 57	8.00	24.30	3.03
1904	Gem, G.L. 65	17.50	6.63	0.39
1905	Do. do.	146.00	145.72	0.99
1906	Do. do.	524.00	460.99	0.88
1907	Do. do.	843.35	399.22	0.47
6¾mths. of 1908	Do. do.	1,110.00	293.58	0.26
	Total	2,648.85	1,330.44	0.50

Two Boys, G.M.L. 74.—This mine, which is situated about 1½ miles north-east from the Township of Kundip, is upon the top of a spur which strikes off from the Ravensthorpe Range in a westerly direction.

The country in which the reef occurs is a belt of highly kaolinized schist which lies immediately upon the western side of the range. A considerable quantity of prospecting had been carried out in this locality consisting of shafts and adits in the kaolin rock, which was supposed to be an alluvial deposit, and it was in one of these that a small ferruginous leader extremely rich in gold was cut at a depth of 40 feet.

Upon following this leader it was found to open out into a flat reef of fair size, and although not nearly so rich as at the point where it was first cut it averaged over 2ozs. of gold per ton. This lode although described as a flat reef has in reality a decided dip to the south-east, in which direction it was found to rapidly increase in size, the inch or two expanding to 6 feet in quite a short distance.

The small vein was traced in a north-westerly direction in order to determine the reason for its non-appearance at the surface, the solution of which was found in the fact that the dip had changed into the opposite direction.

The ore body, which averaged about 3 feet 6 inches in thickness, is composed of a sintery quartz and ironstone, whilst in some places, owing either to chemical action or crushing, portions of it have been converted into a clear white sand rich in gold. It is not by any means a definite body, for portions of it often consist of a network of minor ferruginous veins in the kaolin country adjoining the main fissure. As a rule the roof or hangwall is of a more gritty (siliceous) character to the footwall and in consequence more pervious to the percolation of descending meteoric waters which in all probability played an important part in the deposition of the gold in this vein.

Workings upon a reef of this character have to be carried on more upon the system adopted in coal than that practised in gold mining, and in consequence they would be difficult to describe in detail; it will be sufficient, therefore, to state that it is worked by a series of vertical shafts, the deepest of which is 120 feet, and a series of levels, the deepest being 75 feet below the surface, in which the lode has been driven upon for a length of 300 feet. From between the upper levels the ore is being removed by a series of comparatively flat stopes, the grade of which is so slight that the broken stone will not gravitate but requires passing by hand the whole distance.

At the bottom workings in this mine the lode is cut by a greenstone dyke, but whether it terminates upon this or will be discovered upon the other side has not yet been determined.

As the general direction of the foliation of these schists in which this lode follows the joint planes strikes north-west and south-east, or at right angles to it, and since the belts of rock vary considerably in composition, as might be naturally expected the character of the ore body changes with it, as also do its gold values; for instance, when the roof consists of almost pure kaolin it increases in richness, whilst upon the other hand it becomes poorer when the overlying country is more siliceous.

Table showing the Yield of the Two Boys Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904	Hill End, G.L. 67	12.00	9.83	0.82
1905	Do. do.	25.00	13.70	0.55
1905	Two Boys, G.L. 74	40.00	70.77	1.94
1906	Do. do.	340.00	8 9.18	2.61
1907	Do. do.	8.12	44.38	5.47
To June 1908	Do. do.	717.00	540.91	0.75
	Total	1,142.12	1,568.77	1.40

Hillsborough, G.M.L. 98.—This mine, which was originally taken up for gold, is situated a little to the westward, but upon the same spur of the Ravensthorpe Range as the Gem and the Two Boys.

The lode upon this property strikes in an easterly and westerly direction and underlays at an angle of about 70 degrees to the southward; this has been followed down by an inclined shaft to a depth of 95 feet, the ore body being from three to four feet in thickness to a depth of 75 feet, below which it opens out to a width of 18 feet. It consists of ferruginous quartz for the first 85 feet from the surface, but below this carbonates and oxides of copper make their appearance.

A vertical shaft has been sunk at a point 50 feet to the southward which cuts the lode at a depth of 120 feet (water level) and in a crosscut from it the ore body measured 20 feet from wall to wall for a length of 12 feet. From this a level has been driven west for a distance of 40 feet upon the footwall side of the formation, following a vein of ore three feet in width which has been stoped up and connected with the upper workings at the bottom of the underlay shaft.

At the end of this level the ore vein is suddenly cut out upon a hard bar of country but the fissure line apparently continues through it.

In an easterly direction a level has been driven in the footwall for a distance of 100 feet, but in it no ore was met with after leaving the plat a few feet, whilst at the face the rock in the ore channel has changed in character. Upon the hanging wall a level has also been driven in this direction for a distance of 40 feet, following a vein of ore the average width of which is two feet. Upon the eastern side of the plat the ore fills the entire width between the walls at the roof of the chamber but below it is replaced by a bar of country which rises from the floor, the only continuation in this direction being the small vein before mentioned upon the hanging wall side. Upon the

western side of the plat a little ore is contained all through the formation, but it only continues in this direction as the three-foot vein upon the footwall previously mentioned.

In the stopes above the plat and the western level which have been carried up to a height of 15 feet the ore fills the entire width of the lode channel and this body has now been followed up by a 20 feet rise connecting with the bottom of the underlay shaft.

At the bottom level the formation is contained between two well-defined walls 20 feet apart in foliated greenstone country, whilst the filling matter appears to be an altered diabasic rock. This carries copper ore either disseminated through it in small quantities or concentrated into veins upon either wall, whilst between the two shafts a large bunch fills the entire channel for a length of 12 feet.

Copper sulphide in small quantities is met with at the 120 feet level, whilst gold is often visible in both the stone and the ore.

Table showing the Yield of the Hillsborough Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1906	Hillsborough, G.L. 98 ..	61.00	1.62	..
1907	Do. do.	224.09	1.61	..
		70.57	..	4.35
1908	Do. do. ..	23.14	2.02	..
		35.00	0.19	3.32
	Total	413.80	1.24	0.93

This ore has realised on the average £5 14s. per ton.

Medic, G.M.L. 66.—This lease is situated upon the eastern side of the Steere River, about one mile to the northward of Kundip, and upon it a reef has been opened up which strikes at an easterly and westerly direction with an underlay, which varies from 45 to 70 degrees to the southward.

At the west end of the outcrop a small shaft has been sunk upon a vein of stone which was again cut in an underlay shaft 30 feet farther east; this shaft has been sunk to a depth of 85 feet, and at its bottom the reef has been driven on for a distance of 20 feet both east and west. In the eastern of these the stone was of good value, and from it the shoot was stoped up, crossing the underlay shaft and passing away to the westward at a depth of 40 feet from which point it was worked to the surface at the first mentioned shaft. About 30 feet farther east another underlay shaft has been sunk to a depth of 40 feet upon a well-defined formation, but this unfortunately carried no values. At a distance of 80 feet still in the same direction another underlay shaft has been sunk to a depth of 70

feet, which followed down on a small pipe of stone, from which 25 tons of good ore are said to have been raised.

An underlay shaft, 125 feet farther east, has been sunk to a depth of 120 feet, in which the lode in the upper portion dipped at an angle of about 75 degrees, while below this it flattened considerably. From this shaft a body of stone, said to be about 30 feet in length and averaging 2 feet 6 inches in thickness, was stoped from the bottom level up to the surface at a point a little to the westward of the shaft.

Owing to the difficulty in raising water from these inclined shafts, a main vertical one was sunk to a depth of 170 feet at a point about 100 feet farther south. This cut a formation at a depth of 160 feet, which was driven on for a distance of 100 feet east and 40 feet west. This formation has a well-defined hanging wall, but although a considerable quantity of pyrites and a little galena are present in the ore, it so far has only carried low values.

A rise is now being put up at a point 50 feet east of the main shaft with the object of connecting with the old workings where the ore was rich. In the upper workings the country is highly kaolinised, whilst the main vertical shaft was sunk in solid greenstone from the surface.

The water level is at 80 feet in the main shaft, where a heavy supply was at first encountered, but this has now considerably reduced in volume. This supply, which is not very salt, is pumped to the Two Boys battery, about one mile distant.

Table showing the Yield of the Medic Mine.

Year.	Name and Number of Lease.	Ore crushed	Gold therefrom.	Rate per ton.
		tons.	ozs.	ozs.
1904	Medic, G.L. 66	11.00	7.30	0.66
1905	Do. do.	253.00	2 8.63	0.98
1906	Do. do.	113.90	75.41	0.66
1907	Do. do.	242.00	232.02	0.96
To June, 1908	Do. do.	57.56	34.62	0.60
	Total	677.46	597.98	0.88

Harbour View, M.L. 52 (Plate VII.).—This mine which was the first discovered in this locality, and has up to date produced the largest quantity of both copper and gold in the Kundip group, is situated upon a spur of the Ravensthorpe range, upon the eastern side of the Steere river, about one mile in a northerly direction from the township.

The lode is well defined, its outcrop being exposed in a number of shafts and trenches for a length of over 20 chains upon a bearing

of 21 degrees east of north, whilst its underlay varies between 60 and 75 degrees to the westward. It has a well-defined footwall, the country rock upon this side of the lode being a coarse crystalline greenstone schist.

The hanging wall is only exposed at those points where the formation has been crosscut, and at these it presents a more broken character than the footwall, whilst the country is a much finer grained blocky greenstone.

Between the walls, which are often from 12 to 14 feet apart, is a weathered greenstone schist, in which the ore occurs associated with quartz and iron oxide, the richest portions of which, now worked out, were confined for the most part to the footwall.

The ore in the upper levels is carbonate or oxide of copper with a gangue of ferruginous quartz, but at the 160 feet level a small amount of sulphides are making their appearance.

Judging from the size of the stopes, the portion of the lode worked varied from 1 to 6 feet in width, the ore from which was hand picked, and only that of high grade being sent to the smelting works, whilst the balance, which represented about five-sixths of the total, was treated for gold in the battery.

There are three groups of workings upon this mine, viz., the south, central, and northern; the first mentioned being by far the most extensive (see Plate VII.). Taking these in the above order the developments may be described as follows: No. 1 south underlay shaft has been sunk to a depth of 85 feet upon the grade of the lode, and at this depth a level has been driven for a distance of 100 feet in a southerly direction and 90 feet northerly, at which point there is a slight rise in order to connect with the 80 feet level from the main underlay shaft.

From this level, which is called the south drive, a body of ore has been stoped up to a height of 15 to 20 feet, and for a length of 40 feet north of the shaft and 70 feet south, the total length of this which is called the south shoot is 130 feet, and its average width is 6 feet.

This ore is now being stoped below this level and for a depth of 40 feet the same average size is maintained, whilst the trend of the "shoot" is apparently southerly.

The main underlay shaft has been sunk to a depth of 170 feet, with levels at 35, 80, and 160 feet. The 25 feet level has been driven for a distance of 25 feet north, and the 80 feet level 100 feet north and 25 feet south, in which the ore body was 60 feet in length, and had an average width of 4 feet.

This ore body, which is called the north "shoot," has been stoped up from this level to the surface with apparently a southerly trend, but no work has been done upon it below this level.

In the 160ft. level the formation has been driven on for a distance of 30 feet north and 300 feet south, in the latter of which the south "shoot" of ore was cut at a distance of 130 feet from the shaft and here proved to be 120 feet in length with a width of from 3 to

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4 feet, thus showing a considerable decrease in size from the level above in which it averaged 6 feet.

Although slightly below the permanent water level the sulphides are only just beginning to make their appearance in this drive, whilst in spite of the fact that the copper seems to have been leached from the section of the lode immediately below the surface, so far no signs of secondary sulphides enrichments are apparent.

The central group of workings are situated about midway between the other two; they consist of two shafts, one of which is 60 feet in depth upon the underlay, and from it some ore has been raised.

In the northern workings, which are 110 feet in depth, the lode bifurcates to the southward of the shaft, but whether this is only a spur striking off into the country or will unite after enclosing a horse of country, yet remains to be proved.

Northward of this shaft the lode appears to be again cut off by a cross fault, but since the footwall is so well defined up to it there appears to be no indication of the termination of the fissure, which has more probably been displaced.

In this section of the mine there was so little copper in the stone that it was all sent to the battery for treatment.

Up to the present time 912 tons of ore have been smelted from this mine, averaging 14.36 per cent. of metallic copper and 5,243 tons of stone crushed which yielded .39 ounces of fine gold per ton; this represents about half or a little under of the total gold contents on account of the unsatisfactory battery extraction and the unsuitable character of the ore for cyaniding.

Table showing the Yield of the Harbour View Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1900	Harbour View Leases, M.L. 52 and 94	23.00	1.39	36.00
1901	Do. do. ..	209.20	1.66	18.69
1902	Do. do.	272.75	..	5.63
		1,492.75	0.39	..
1903	Do. do.	6.69	..	9.00
		296.00	0.56	..
1904	Do. do.	43.99	..	20.39
		1,254.50	0.43	..
1905	Do. do.	48.73	..	14.24
		576.0	0.50	..
1905	Ravensthorpe G.M. Syndicate, N.L.	94.89	..	15.92
		701.00	0.52	..
1906	Do. do.	32.79	..	25.67
		423.00	0.15	..
1907	Do. do.	4.88	0.39	17.00
1907	Harbour View Leases	52.74	..	17.00
		500.00	0.18	..
To June, 1908	Do. do. ..	122.17	0.37	15.65
	Total	6,155.08	0.41	2.14

This ore has realised an average value of £3 per ton.

Omaha and *Harbour View North*, G.M.Ls. 73, 81.—These leases, which are situated to the northward of the Harbour View mine, together with the Kundip and the Star of Peace, were included in the original Omaha, M.L. 132, which was worked in 1902 and 1903.

So far no well-defined lode has been discovered upon them, but small veins have been worked upon at no less than six different points.

Table showing the Yield of the Omaha Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1902	Omaha, M.L. 132	241.00	0.34	..
1903	Do. do.	9.15	..	15.00
1905	Omaha, G.L. 73	43.50	3.55	..
1906	Do. do.	50.44	2.11	..
1907	Do. do.	10.00	3.26	..
	Total	354.09	1.04	.00

Table showing the Yield of the Harbour View North Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1906	Harbour View North, G.L. 81	31.00	0.67	..
		1.44	..	19.44
1907	Do. do.	50.00	0.54	..
		1.48	..	1.35
To June, 1908	Do. do.	31.00	0.37	..
	Total	114.92	0.51	0.03

Ore has realised £2 8s. per ton.

Table showing the Yield of the Kundip Mine.

Year.	Name and Number of Lease.	Ore crushed.	Gold therefrom.	Rate. therefrom.
		tons.	ozs.	ozs.
1906	Kundip, G.L. 78	50.00	20.74	0.41
1907	Kundip, G.L. 133	161.00	43.82	0.27
	Total	211.00	64.56	0.30

Flag Gold and Copper Mining Co., Ltd., G.M.Ls. 136/9 (Plate VIII.).—This mine, which was originally known as the Red, White, and Blue, is situated upon a spur of the Ravensthorpe Range about one mile to the eastward of Kundip Township.

Across leases 136, 137, and 138 upon a course a little south of west are a series of shafts and opencuts which are assumed to have proved the continuity of a line of lode for a distance of 1,100 feet. Owing however to the very great irregularity in its course at the different points at which it has been opened upon, this assumption although quite possible is by no means conclusive, for so far the longest drive is only 230 feet, and even in this the ore body is not continuous.

Upon the other hand the erratic course of the lode may be due to the fact that since this line of fissure crosses the schistose rocks at nearly right angles it would in all probability have been deflected by their planes of foliation.

At the extreme western end of this line of workings a small shaft has been sunk to a vertical depth of 20 feet with a short drive at its bottom to the eastward upon a small vein of ore which measures 2 feet 5 inches in thickness and assays 2.6 per cent. of copper and 13 dwts. of gold.

To the eastward of this shaft the lode, which has a course of 28 degrees south of west, has been worked from an opencut for a length of 65 feet and to a depth of from 10 to 15 feet, its average thickness being about 2 feet 6 inches and value 6 per cent. of copper and 9 dwts. 14 grains of gold. At the east end of this cut another small shaft has been sunk to a vertical depth of 30 feet and the vein which was cut measured 2 feet in thickness and assayed 7 per cent. of copper and 1 oz. 2 dwts. of gold.

One hundred feet farther east is another opencut in which the lode had a course of 21 degrees south of west, averaging 3 feet in thickness for a length of 30 feet and having an assay value of 1.23 per cent. of copper and 9 dwts. 19 grains of gold.

A little south of this a vertical shaft has been sunk to a depth of 30 feet and the lode which is here 5 feet in thickness has been driven upon for a short distance to the eastward, from which 23 tons were sent to the battery and yielded at the rate of 11 dwts. 10 grs. of gold per ton. This ore was of a highly ferruginous character and contained some rich nodules of copper.

At a distance of 100 feet east is an opencut which is the top of a stope from which a body of ore has been worked out, the course of which was 20 degrees north of west for a length of 30 feet. A little east of this a vertical shaft (No. 2) has been sunk to a depth of 100 feet (water level), whilst at a depth of 50 feet the lode has been driven upon for a length of 75 feet and the ore body which was here of considerable size has been stoped up to the surface for a length of 30 feet to the point previously mentioned.

At a depth of 100 feet the lode, which has a course a little north of east and underlays at an angle of 66 degrees to the southward, has been driven upon for a distance of 320 feet, this level connecting with the No. 1 shaft at a distance of 230 feet. At this level at the bottom of No. 2 shaft there was no ore for the first ten feet, after which a large body measuring 9 feet 9 inches in thickness and assaying 8dwts. 8 grains of gold was met with; then, after another blank of 30 feet for a distance of 140 feet, a lode body averaging 3 feet in thickness and assaying 14 dwts. of gold is exposed followed by 40 feet of barren country. After passing the No. 1 shaft some 15 feet, driven in barren country, the main ore body of the mine is encountered and driven through for a length of over 70 feet, in which length its average width was 3 feet. The ore between this level and the surface has been entirely stoped out; that rich in copper was picked out by hand; it is reported to have been worth 8.8 per cent. of copper and 1oz. 17dwts. 19grs. of gold per ton, whilst the bulk of the ore which was treated in the battery assayed 1oz. 16dwts. for gold.

Below this level this ore body has been followed down by a winze to a depth of 45 feet and a portion of it stoped which measured four feet in thickness and the picked smelting ore from which assayed 6.32 per cent. for copper and 2ozs. 2dwts. 16grs. for gold.

The new main shaft has been sunk at a point 220 feet south-easterly from the No. 1 shaft to a depth of 210 feet from which, at 200 feet, a crosscut has been driven for a distance of 105 feet in a northerly direction to the lode. From this point it was driven upon in a westerly direction for a distance of 40 feet, whilst the vein, which was heavily charged with pyrites in this level, averaged four feet in thickness and assayed 1oz. of gold. In the face, however, the values were improving as a sample taken from there gave a result of 3 per cent. of copper and 2ozs. 1dwt. of gold.

This is supposed to be the downward extension of the main ore body worked in the upper levels, but this cannot be the case, for if it maintains its dip to the eastward, as it appears to do, the continuation will be met with in the level when driven in an easterly direction from the crosscut.

At a point a short distance easterly of the No. 1 shaft an underlay shaft has been sunk upon a small body of ore which follows a course of 40 degrees north of west and dips to the north-east to a depth of 100 feet, the bottom of which is connected with the former by a drive of 110 feet in length at the 80-feet level.

In this vein, which is called the Eastern Leg, a pipe of ore about 20 feet in length and 3ft. 9in. in thickness has been stoped out, the picked ore assaying 11.6 per cent. of copper and 13dwts. of gold.

About 200 feet farther east a ferruginous lode 2 feet in width and assaying 17dwts. 23grs. of gold outcrops upon a course 45

The Hon. H. Lefroy M.L.A.
Minister for Mines.

PLAN & SECTION OF
THE FLAG MINE
KUNDIP
PHILLIPS RIVER G.F.

0 100 200 300
Scale of Feet

Stoped

PLAN

G.M.L. 138
EASTERN FLAG

Nº2 LODE

G.M.L. 137
FLAG

G.M.L. 136
WESTERN FLAG

DAM

TAILINGS

BATTERY

OPEN CUT
Nº3 SHAFT
OPEN CUT
Nº2 SHAFT
OPEN CUT
Nº1 SHAFT
EAST LEG SHAFT

QUARTZ LODE
IRON CAP LODE
IRON CAP SHAFT

MAIN SHAFT

LONGITUDINAL SECTION

MAIN SHAFT
IRON CAP SHAFT
Nº3 SHAFT
Nº2 SHAFT
Nº1 SHAFT
EAST LEG
70 FT LEVEL
CROSS CUT
Water Level
100 FT LEVEL
200 FT L

C.B. Kidson, del

TAKEN FROM MINE PLANS 30. 6. 08.

H. J. Pether Government Lithographer Perth W.A.

degrees north of west with an underlay of 45 degrees to the north-east. This vein was followed down upon the incline to a depth of 70 feet, the upper 20 feet carrying practically no copper values; at this depth however some large bunches of copper ore were met with and the gold values rose. At a depth of 60 feet it developed into a copper lode the ore occurring as a pipe 25 feet in width and from 3 to 6 feet in thickness.

At 70 feet a level has been driven for a distance of 90 feet, 70 feet of which was in lode matter which averaged about 5 feet in thickness and portions of it assayed as high as 18 per cent. of copper and 1oz. 3dwts. of gold.

In this level the lode swings round on to a more east and west course whilst in the winze, which has been sunk 25 feet below it, the dip also turns over to the southward. In this winze the lode is 4 feet in width and assays 7 per cent. of copper and 1oz. 3dwts. of gold.

In driving in a westerly direction at the 70-feet level a large vugh lined with ferruginous gossan was broken into. The roof of this cavity was coated with some fine specimens of malachite, whilst at the bottom there was a considerable quantity of free white sand containing fragments of honeycombed quartz which yielded good prospects of free gold: this latter, however, was of considerably less value than that generally obtained in this mine owing to the presence of a large quantity of silver.

This vugh is not a solitary example in this mine for a similar one of even greater dimensions was met with in driving the 100ft. level in the main workings. They are clearly due to the decomposition of large bunches of pyrites the iron and sulphur from which have been leached out, leaving only the quartz with the gold and silver contents as white sand, whilst the malachite has been precipitated by downward perculation at a later date.

From these workings, 114 tons of ore have been smelted, which yielded 1oz. 2dwts. 14grs. of gold and 10.8 per cent. of copper per ton, whilst 344 tons crushed returned gold at the rate of 14dwts. 7grs. per ton.

About 300 feet farther east is another open cut exposing a large quartz lode having a course 13 degrees north of west, from which a quantity of stone has been crushed which yielded 13dwts. of gold per ton.

At a distance of 300 feet north there is another line of lode following a course of 32 degrees south of west which has been opened by a series of pits and trenches for a length of 200 feet, whilst a vertical shaft has been sunk to a depth of 40 feet at the bottom of which the lode splits into two veins, the footwall one being 10 inches in thickness and assaying 16 per cent. of copper and 13dwts. of gold whilst the hanging wall vein is 12 inches wide and assays 1oz. 17dwts. 18grs. From these workings 6 tons of ore were smelted which yielded 18 per cent. of copper and 1oz. 7dwts.

of gold per ton; and 39 tons were crushed returning 16dwts. 9grs. of gold per ton.

The main lode is highly ferruginous in part, particularly where copper is present, whilst the other more highly siliceous portion carries only gold. The ore is oxidised in all the upper workings but traces of sulphide such as bornite and copper glance occur below the water level in the winze, whilst the ore at the 200-feet level consists principally of sulphide of iron with only traces of copper.

The lode is not well defined, good smooth walls being quite of rare occurrence; whilst the deposition of copper in the lode appears to have been influenced by the character of the rock through which the fissure has cut, the shoot-like enrichments following down the intersection of their foliation planes.

The water level was originally 100 feet below the surface, but since it was drawn at the rate of 60,000 gallons per day whilst working at the 200ft. level, this has been considerably lowered in the upper workings. The water is salt but not extremely so, the quantity contained being only 1.5 per cent.

Taken upon the whole this is more correctly speaking a gold mine which contains copper ore in portions of high enough value to smelt. What its character will be in the sulphide zone will shortly be proved when work is recommended at the 200ft. level.

The great drawback up to the present has been the exceedingly poor extraction by battery treatment which has only been from 40 to 50 per cent., whilst owing to the presence of copper this has been unrecoverable with cyanide of potassium.

Table showing the Yield of the Flag Gold and Copper Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper therefrom.
		tons.	ozs.	%
1901	Red, White and Blue, M.L. 60	10.75	..	24.56
1902	Do.	185.50	.22	
1903	Do.	7.97	..	19.07
1904	Do.	42.34	..	16.10
		508.10	.67	
1905	Do.	171.96	..	11.43
		250.00	1.84	
1906	Do.	62.00	.78	
		216.42	..	8.00
1907	Flag, G.L. 136–9	40.06	..	6.90
		665.00	.66	
To June, 1908	Do.	149.39	1.15	7.42
		359.00	.50	
	Total	2,668.49	.70	2.32

This ore has realised an average value of £4 5s. per ton.

ADDENDA.

The Department is indebted to Mr. Robert Hastie, a former Minister for Mines, for the following table giving the total yield of the Flag Gold and Copper Mine up to date.

A. G. M.,
G. G., 24-6-09.

Summary of the Ore treated from the Flag Mine, showing the gross tonnage, gross contents, and values. Values of Copper taken at market price at time of delivery and Gold at £4 per ounce.

By present Company from inception to May 31st, 1909:—

	Tonnage.	Tons Copper.	Ozs. Fine Gold.	Gross Value.
				£ s. d.
Sold to Smelter up to 31-12-08	808·3625	75·0	968·844	8,910 14 5
Do. do. 31-3-09	981·5	63·947	832·350	7,079 11 1
	1789·8625	138·947	1801·194	15,990 5 6
			Bullion. oz. dwt. gr.	
Crushed at Company's Battery up to 31-5-09	3511·5		2,421 4 11	7,177 19 2
	5301 3625	138·947	4222·394	23,168 4 8

Previous to March, 1907, the mine was known as the Red, White and Blue. It produced:—

	Tonnage.	Tons Copper.	Ozs. Gold.	Gross Value, estimated at £60 per ton Copper and £4 4s. per oz Gold.
				£ s. d.
Red, White, and Blue ...	1222·5	39·11	880·11	6,043 11 3
Flag	5301·3625	138 947	4222·394	23,168 4 8
Total Production of Mine	6523·8625	178·057	5102 504	£29,211 15 11

Charmion G.M.L. 132.—This lease is situated upon the same spur of the range, but farther to the eastward than the Flag mine; it was worked in 1906 as the Persic G.M.L. 85, and the Persic Extended G.M.L. 95.

Quite a number of prospecting shafts have been sunk to shallow depths upon two series of small ferruginous quartz veins in a kaolinised schist, one series which strike north and south apparently occur as short lenses, whilst these which follow a more east and west course can be traced for a considerable distance.

Both of these lines of reef have in places yielded very good prospects at the surface, but they did not as a rule carry these values down. These veins are in the same belt of country as the Gem and Two Boys, the reefs in which did not carry values in their upper portions, the poorness of the stone in the shallow workings is therefore no criterion as to its richness at a depth which can only be determined by sinking.

Up to June, 1908, the total production from this area as shown in the official returns under the Persic, Persic Extended, and Charmion is 47½ tons of stone which yielded 28.81 ounces of fine gold.

Try Again G.M.L. 114.—This lease covers a triangular block of ground between the Flag mine and the Charmion, and upon it a number of shafts have been sunk with the object of cutting the lode worked upon the first named property. So far however only a series of small ferruginous quartz veins have been discovered, from which 9½ tons of stone yielded 7.10 ounces of fine gold.

Hecla (late Mt. Pleasant), M.L. 206.—This mine is situated about one mile west of the Mosaic, and upon it a lode striking north and south with a steep dip to the east but nearly vertical has been worked. An adit was first driven into the hill at the south end of the outcrop, whilst later on a vertical shaft was sunk to a depth of 70 feet in formation all the way down.

This formation, which is from 10 to 15 feet in width, consists of kaolinized rock containing nodules of blue and green carbonate of copper, 28.86 tons of which yielded 3.55 tons of metallic copper valued at £308; this ore carries no gold.

Mosaic, M.L. 291.—This mine is situated about four miles from Kundip upon the eastern side of the Ravensthorpe Range. It is not included in the area geologically mapped.

The lode, which has a course of north-west and south-east with a dip of about 70 degrees to the north-east, was first opened up at its north-west end by a vertical shaft 30 feet in depth, and later by an underlay shaft 75 feet deep about 40 feet farther south-east. This latter shaft was sunk in the ore body, which varied from 3 to 4 feet in width, one foot of which is said to have been solid clean ore. About 50 feet farther south-east another underlay shaft has been sunk to a depth of 110 feet upon the other end of the shoot, and in it the vein presents the same character as in the last mentioned.

The ore as a rule does not continue south beyond this shaft, but at one or two points small veins have been followed for short distances, whilst at a depth of 75 feet it has been entirely cut off by a fault dipping to the south-west.

The ore body is about 80 feet in length, and this appears to have been entirely stoped out up to the surface.

After penetrating the fault plane the lode was lost, but was eventually discovered by crosscutting in a north-easterly direction, where it proved to be small and of low value. It was driven on from this point in a south-easterly direction for a distance of 40 feet, whilst the vein which was small and of low value was underhand stoped throughout the entire length to a depth of 12 feet, the ore being raised to the surface by a vertical shaft which connects with this level.

The country rock is talcose schist with magnesite nodules at the surface, whilst the ore is of interest, as this is the only mine upon this field in which Fahl ore is known to exist.

Table showing the Yield of the Mosaic Mine.

Year.	Name and Number of Lease.	Ore treated.	Gold per ton.	Copper per ton.
		tons.	ozs.	%
1904	Mosaic, M.L. 179	33.72	0.23	13.76
1905	Do. do.	19.76	0.20	8.00
1906	Mosaic, M.L. 237	1.67	0.71	11.40
1907	Mosaic, M.L. 291	10.04	0.35	9.56
To June, 1908	Do. do.	7.06	0.45	9.20
	Total	**72.25**	**0.30**	**11.08**

This ore has realised an average of £7 per ton.

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GOVERNMENT ASSAYS.

Assays, Analyses, and Determinations of any Western Australian Ore or Rock will be made by the Assayer to the Geological Survey, **when not unduly interfering with official work,** subject to the following conditions :—

1. Each sample must weigh at least 6oz., but not more than 2lbs.
2. Each sample must be enclosed in a separate canvas bag or strong paper wrapper, with a slip of paper bearing the name and address of the sender, together with a private mark by which it may be readily identified.
3. The parcel must be forwarded, **prepaid,** to :—

   The Government Geologist,
   Geological Survey Office,
   Perth.

4. A letter must be sent at the same time to the same address, stating for what metals the samples are to be assayed, or containing other instructions, as the case may be.

(N.B.—It is always advisable to keep duplicate samples of those submitted.)

5. Before any assay is made the prescribed fee must be paid to the Mineralogist and Assayer, or sufficient reasons, in accordance with Section 7 below, be furnished for having the samples treated free of cost.

6. The following fees will be charged :—

	£	s.	d.
(a.) Determination of a Rock or Mineral	0	10	6
(b.) Assay for Lead, Iron, or Manganese, each ..	0	10	6
(c.) Assay for Silver, Copper, or Tin, each	0	12	6
(d.) Assay for Gold or Zinc, each	0	15	0
(e.) Dry Assay for Lead, Silver, and Gold	1	1	0
(f.) Assay for Antimony, Bismuth, Chromium, Cobalt, Mercury, or Nickel, each	1	11	6
(g.) Proximate Analysis and Calorific Valuation of Coal	1	11	6
(h.) Complete Chemical Analysis of any Mineral or Ore, according to number and nature of determinations .. .. £2 12s. 6d. to	5	5	0
(i.) Other determinations, according to time spent up to	2	12	6

A reduction of 20 per cent. on the above amounts will be made in favour of any person submitting, in one parcel, five or more samples for identical treatment.

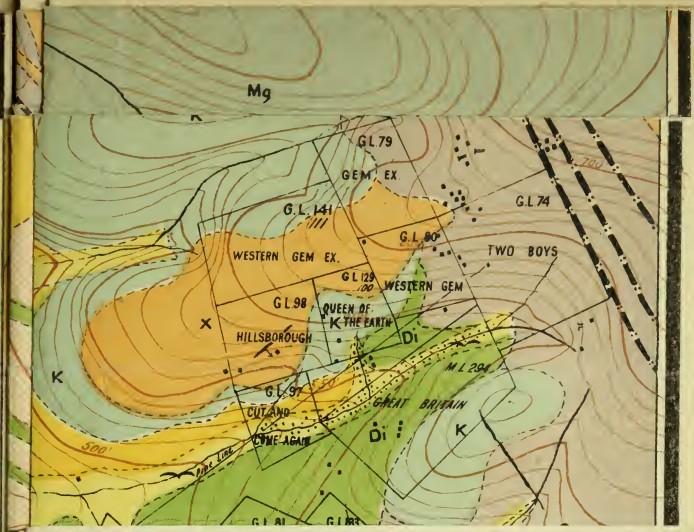
7. With the object of encouraging bona fide prospecting, free Assays will be made under the following circumstances :—

   (a.) The sample must have been obtained from land within the State not held under lease for mining purposes.
   (b.) The exact locality where the sample was found must be disclosed.
   (c.) The sample must be of sufficient promise to warrant an assay being made at the expense of the State.
   (d.) Free assays will not be made of samples showing free gold, or of tailings or other metallurgical products, or of umpire samples.

8. The Department reserves to itself the right of refusing to make any particular Assay, and also the right of publishing at any time the results of an Assay made at the public expense.

A. GIBB MAITLAND,
Government Geologist.

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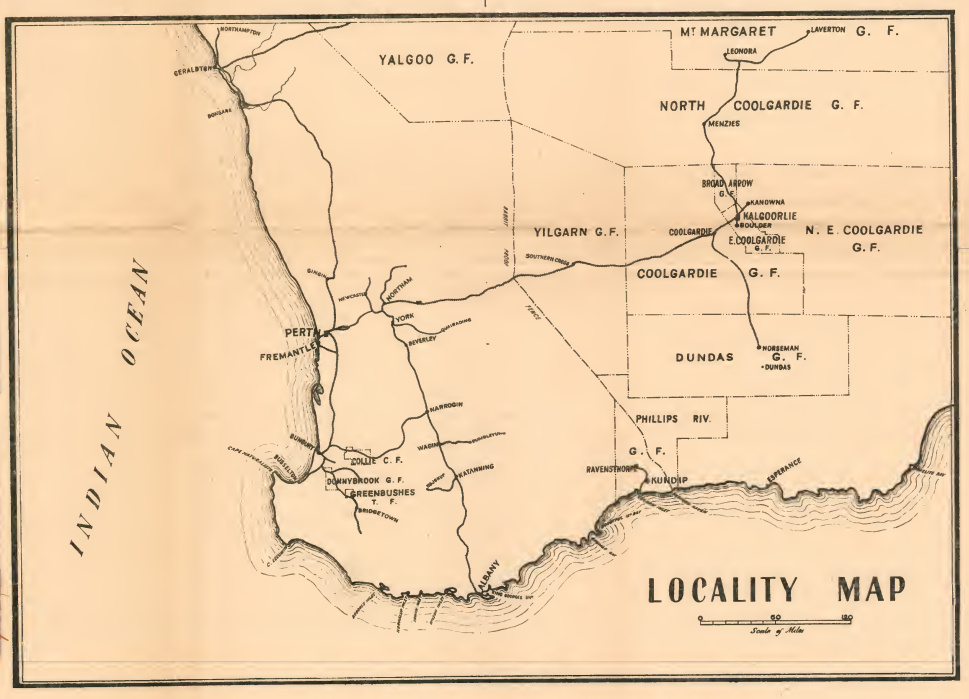
DESMOND & KUNDIP

PHILLIPS RIVER G. F.

0 20 40 60 80
Scale of Chains

BULLETIN No 35

Hon. H. Gregory M.L.A.
Minister for Mines.



LOCALITY MAP

Scale of Miles



A Gibb Maitland
Government Geologist.

GEOLOGY BY H. P. WOODWARD ASSISTANT GOVERNMENT GEOLOGIST
AND H. W. B. TALBOT FIELD ASSISTANT.
DRAWN BY R. H. IRWIN.

EXPLANATION OF COLOURS AND SIGNS

ALLUVIUM	~	QUARTZ DIORITE	Qdi
SUPERFICIAL	≈	BASIC SCHISTS	Sc
LATERITE	X	SERPENTINE	Mg
TRAVERTINE	Ca	ACIDIC SCHISTS	Gs
SANDSTONE	K	GRANITE	Gn
GREENSTONES	Di	BANDED QUARTZITES, QUARTZ REEFS	Q

Contour lines at 10ft intervals (710', 700')

GEOLOGICAL BOUNDARIES
SHAFTS
LEASES: GOLD G.L. / MINERAL M.L. / MINERS HOMESTEAD M.H.L.
WATER RIGHT W.R.
MACHINE AREA M.A.
BUSINESS " B.A.
GARDEN " G.A.

H. J. Pether, Government Lithographer, Perth, W.A.

The Hon. H. Greenwy M.L.A.
Minister for Mines

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

RAVENSTHORPE

PHILLIPS RIVER G. F.

Scale of Chains 20 40 60 80



LOCALITY MAP

A. Gibb Maitland
Government Geologist.

RAVENSTHORPE TOWNSHIP

GEOLOGY BY H. P. WOODWARD ASSISTANT GOVERNMENT GEOLOGIST AND H. W. B. TALBOT FIELD ASSISTANT.

DRAWN BY R. H. IRWIN. December 1908

H. J. Fechter, Government Lithographer, Perth W.A.

EXPLANATION OF COLOURS AND SIGNS

ALLUVIUM
SUPERFICIAL
LATERITE
TRAVERTINE
SANDSTONE
GREENSTONES
QUARTZ DIORITE
BASIC SCHISTS
ACIDIC SCHISTS
GRANITE
FELSITE & PEGMATITE DYKES.
QUARTZ REEFS.
Numbers here at 100' intervals

GEOLOGICAL BOUNDARIES
SHAFTS
WATER RIGHT
MACHINE AREA M.A.
BUSINESS " B.A.
GARDEN " G.A.
LEASES: GOLD G.L. MINERAL M.L. MINERS HOMESTEAD M.H.L.

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